1949

NEW ZEALAND

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

(TWENTY-THIRD ANNUAL REPORT OF THE)

Presented to Both Houses of the General Assembly by Leave

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MINISTER'S STATEMENT

In the Department of Scientific and Industrial Research provision has to be made to deal with science and research from a number of different standpoints. At one extreme the day-to-day service problems of Government Departments and industry require the scientific attention so essential to modern sound administration; at the other extreme, that reservoir of scientific truth from which all new knowledge springs has to be replenished by fundamental research. This is being achieved partly by grants to University colleges and partly by effort in the Department's own branches. In between these two limits there exists a large number of different types of activities. Research committees and associations provide for the problems of specific industries; branches of the Department deal with research into soils, pastures, crops, plant diseases, insect pests, botany, and biometrics, which are of interest to farming industries in the main; other branches cater for the service, development, and research needs of manufacturing industries, with their physics, chemistry, and engineering problems. The structural geological characteristics and mineral resources of New Zealand are in the province of the Geological Survey, and between the Survey and the Observatories (dealing with terrestrial magnetism, seismology, ionospherics, and oceanography) close association of effort exists on a number of problems of local and international significance.

In the year ended 31st March, 1949, the Department of Scientific and Industrial Research, in its various branches, has contributed markedly to the solution of problems affecting the interests of the primary and manufacturing industries of the Dominion and various Departments of State.

Results have come rather from an aggregate of small achievements in a large number of fields rather than from a few outstanding developments. The position has now been reached when the demands made on the Department for assistance are greater than its resources of man-power and accommodation can provide for. This involves some postponement of work which is recognized as being of real national importance, and this, regrettable as it may seem to be, is an indication of the extent to which scientific guidance is necessary for both industry and Government.

In a country such as New Zealand the range of problems requiring scientific assistance is necessarily wide, and it has been the policy of the Department to render help wherever possible. This has left it open to the charge of dissipation of effort, a criticism which has been partly justified, but which has been met by the establishment of branches and research associations which focus attention on the problems of particular groups with common interests.

It is generally accepted to-day that only by collaborative action on the part of scientists trained in different techniques can problems be satisfactorily attacked and speedily solved. The departmental organization has been arranged to make provision for such co-operative attack, and a number of problems are being dealt with to-day on a collaborative basis, which often includes joint effort with other Departments.

Every effort has been made to shorten the time between the attainment of useful results and their being put into practice, despite difficulties experienced in rapid publication of results.

Full use was made of the help available from the presence in New Zealand of some 200 overseas scientists on the occasion of the Seventh Pacific Science Congress. It is impossible to assess the great value accruing to New Zealand's scientific effort from the exchange of ideas which took place during a Congress which was a pronounced success and a unique occasion in New Zealand's scientific history.

The Commonwealth aspects of scientific effort also received consideration arising out of the visits of Sir Ben Lockspeiser, Chief Scientist of the Ministry of Supply, Great Britain, and Sir Henry Tizard, Chairman of the Defence Research Policy Committee and of the Advisory Council on Scientific Policy of Great Britain.

In view of the importance of the world food situation, further consideration is being given to this aspect of the Department's activities and scientific guidance is being sought in this matter from the United Kingdom authorities.

Recognition of the pre-eminent importance of our soil resources has resulted in the completion of the general soil surveys of both the North and the South Island, which are providing the basic information for detailed surveys relating to specific problems such as those connected with closer land-settlement in the Taupo and Southern Wairarapa districts, soil erosion, and the areas in which mineral deficiencies occur.

Intensive work on the improvement in the quality of pasture for all types of country has shown results in improved strains of rye-grass and cocksfoot which have been proved this year. In rye-grasses, cocksfoot, and clovers, prolonged tests have shown that our research work has produced lines which provide under New Zealand conditions marked increases in food values in comparison with the best selections from overseas, a factor which must have a considerable potential influence in the economy of production from New Zealand's pastoral lands.

Considerable progress is being made in the understanding of pasture response to top-dressing with phosphates, nitrogen, and potash. Attention focused on the nitrogen problem has shown that an entirely new view of nitrogen intake by the grazed pasture plant and its use in the leaf has to be adopted. Advances are being made also in the knowledge of methods for improving pastures in the hill country of both Islands. This progress is important in a country so dependent upon grass for its economic welfare.

Improvements in the quality of stock fodder crops, such as swedes, kale and lupins, which have resulted from plant breeding work, will also be helpful towards supplies for sheep and cattle.

An intensive programme of research on insect pests and fungus, bacterial and virus diseases of all farm crops, is being maintained, and a number of useful results were secured during the year. The heavy toll exacted annually by plant pests and diseases is seldom recognized, and work in this field continues to pay handsome dividends.

Three new apple varieties of English origin and five varieties of peaches from Australia, after exhaustive tests, have been selected for issue to New Zealand growers. The importance of helping the fruit industry in its difficult problem of frost-fighting has necessitated the continuance of a comprehensive series of investigations.

The value of research to a primary industry is well exemplified in the case of tobacco research, where, as the result of close collaboration between the Departments of Scientific and Industrial Research, Industries and Commerce, and Agriculture, the Cawthron Institute, growers, and manufacturers, a steady flow of information of great value to the industry as a whole emerges each year. The recently established Hop Research Station shows similar promise and already much useful preliminary work has been done on varietal, disease, and curing problems, despite serious handicaps.

Plant-breeding work at the Wheat Research Institute gives promise of varieties even better in quality than Hilgendorf, which is being rapidly multiplied now for extended commercial use.

In view of the very extensive field covered by agricultural research, grants are being made each year to Cawthron Institute, Massey College, and Lincoln College to enable a better coverage to be achieved in this sphere. Very valuable results have been secured and the policy does much to promote co-ordination of effort and exchange of ideas between the workers of these institutions and the Department.

A marked increase in the activities of the Geological Survey took place during the year as a consequence of additional staff becoming available to deal with coal survey and hydro-electrical dam site surveys. In both spheres, geophysical methods and equipment are being extensively used, and the application of these to New Zealand's problems is likely to both expedite and improve the quality of the results. Studies in volcanology and the use of geothermal power have been inaugurated.

The extent to which State Departments and industry rely on scientific assistance is well exemplified by the very extensive range of work done by the Dominion Laboratory and its branches. This is essential service work in a modern community, and its standard has been maintained at a very high level of reliability. In addition to service work, a growing volume of research work is being undertaken for industry. This work is now including some of the very difficult but highly useful new methods where radio-active isotopes are being employed.

In the sphere of physical and engineering research, development, and service the volume of work has been steadily increasing, so that the Auckland Industrial Development Laboratories, the Dominion Physical Laboratory, and the Canterbury College Industrial Development Department continue to fill a very important role in providing assistance in many fields for both State Departments and manufacturing industries. During the year all these institutions have devised plant and equipment of an original kind which seems likely to be very advantageous to local manufacturers. The importance of having such facilities available in New Zealand is recognized as essential to reaching and maintaining a high standard in New Zealand's manufacturing industries.

Developments overseas in the fields of electronics, nuclear physics, and geophysics are of great significance to New Zealand, and work in all these spheres of activity has been in full operation and is being extended.

A reorganization of the geophysical branches was carried out during the year to provide for improved operation of the magnetic survey, ionosphere, seismology, and oceanographic activities of the Department, which also involve fulfilment of a number of international scientific obligations.

The continued interest of the manufacturing industries, expressed through the Manufacturers' Research Committee, has had a highly advantageous influence in the promotion of science and its understanding. The operations of five research associations have been progressively beneficial to the industries they are serving as evidenced by the reports issued to members and the interest displayed in the extension of their activities. In this form of research organization the close association of the scientist and industrialist ensures the rapid implementation of results secured.

Grants in promotion of research are now being made to all the New Zealand University colleges and to Cawthron Institute by the Department to foster lines of activity which are of common interest and to secure an increasing measure of collaboration with the University. It is pleasing to note the growing association in research which is developing between the staffs of the University colleges, Cawthron Institute, and State Departments.

An exhaustive survey of the scientific man-power resources and requirements of the Dominion was completed during the year, and its results will provide a valuable basis for the development of policies both in the training and the utilization of scientists to meet New Zealand's needs in the future.

T. H. McCombs,
Minister in Charge of the
Department of Scientific and Industrial Research.

SECRETARY'S REPORT

The Hon. T. H. McCombs, Minister in Charge of the Department of Scientific and Industrial Research.

I have the honour to submit herewith the annual report of the Department for the year 1948–49.

During the year under review there has been a slight expansion of activities, but more particularly a consolidation of the whole organization has been apparent. The year has been a notable one in that it has seen a very considerable strengthening of our relationships with kindred organizations and research workers overseas, brought about in a twofold manner: firstly, through the holding in New Zealand of the Seventh Pacific Science Congress, attended by some 200 eminent scientists from overseas; and secondly, by the sending of a number of senior officers overseas to study or to undertake special investigations, or to represent New Zealand at Commonwealth and international scientific conferences. The benefits are immediate, continuing, and substantial. The Department's Scientific Liaison staffs in London, Washington, and Melbourne greatly promote the continuation of the collaboration initiated by these exchanges of visits.

Unfortunately it has not as yet been possible to implement the recommendations of Sir Reginald Stradling for the establishment of a Building Research Station in New Zealand, but it is anticipated that definite action will be taken during the coming year.

There has been a considerable increase in the number of requests for scientific and technical information and assistance from other Departments of State and from industry, and this indicates that the Department's services are meeting a definite need. There is a growing realization in industry that if the Dominion is to maintain or improve its position with regard to overseas competition it must have the benefit of the most recent appropriate scientific information.

Some reorganization has taken place within the Department to give better conditions for the functioning of various activities. The Observatories have been arranged into four separate closely co-ordinated units. Fruit Research has been established as a separate entity. The Industrial Psychology Division has been changed so that its scope is purely research. Service work has been transferred to the Personnel Advisory Division of the Department of Labour and Employment, with which close co-ordination of effort has been established. The Defence Development Section has been transferred to the control of Canterbury University College, where it will function in providing scientific services to the South Island manufacturing industries.

Certain major difficulties referred to in previous annual reports remain, especially those of accommodation and shortage of senior experienced scientific officers. These difficulties continue to affect seriously the nature of the service that the Department is able to give.

Defence science matters have received continuous and close attention during the year, and the fullest collaboration has been maintained with the Services.

The record of achievement in all branches of the Department, as set out in this report, is one of general sound advancement in a great number of directions. Every branch has reached attainments likely to have far-reaching influences on the national welfare of New Zealand, and the policy of the Department to expedite the putting into operation of all results of commercial value has been continued. The work of the Research Council and its many advisory research committees and research associations has been of the greatest importance and value in this sphere, and has done much to

ensure the maintenance of a sound balance between scientific effort and its practical application. I wish to record the Department's grateful appreciation of the very real assistance rendered by research committees and research associations in the implementation of its policy whereby interested industries are able to actively participate in the financing and programme guidance of many of its research activities.

RESEARCH COUNCIL

The Research Council met on five occasions during the year. It is desired to record the Department's indebtedness to the members of the Council for their very able guidance and close interest in the policy and activities of the Department. The personnel of the Council was as follows:—

T. Rigg, K.B.E., M.A., M.Sc., F.R.I.C., F.R.S.N.Z. (*Chairman*).
J. C. Andrews, Ph.D., M.Sc. (*Deputy Chairman*).
N. L. Edson, B.Med.Sc., M.B., Ch.B., Ph.D. (Cantab.).
E. J. Fawcett, M.A. (Cantab.).
E. R. McKillop, O.B.E., M.I.C.E.
R. O. Page, D.Sc.
J. M. Ranstead, Bledisloe Medallist.
W. Riddet, B.Sc. (Agric.), N.D.A., N.D.D.
D. F. Sandys Wunsch, M.A. (Oxon.), B.Sc. (McGill.), M.I.Chem.E., Assoc.Inst.M.M.
F. R. Callaghan, M.A., F.R.E.S. (*Secretary*).

EXPENDITURE

The net expenditure for the year amounted to £677,268. The following was the expenditure incurred in the various branches of the Department:—

	£
Head Office	45,553
Research investigations	248,108
Dominion Laboratory	90,489
Dominion Observatory	5,045
Geological Survey	62,776
Magnetic Observatory	8,381
Dominion Physical Laboratory	140,752
Grants to University and Agricultural Colleges	33,541
Grants to research associations	24,000
Grants, statutory and miscellaneous	12,828
Grants to allied institutions in the United Kingdom	9,413
Information Bureau, Scientific Liaison Services, and miscellaneous services	64,647
Auckland Industrial Development Laboratories	23,087
Apia Observatory	5,818
	774,438
Less recoveries	97,170
	£677,268

PERSONNEL

The number of staff of the Department and its disposition at the 31st March, 1949, was as follows:—

Agronomy, Botany, Entomology, Grasslands, and Plant Diseases Divisions	161	Fats Research Laboratory	17
Auckland Industrial Development Laboratories	26	Geological Survey	63
Dominion Laboratory and district branches	135	Head Office (including Information Bureau and district offices)	145
Dominion Physical Laboratory	203	Observatories	38
		Soil Bureau	74
		Miscellaneous	64

Total staff, including clerical officers, typists, technicians, and professional officers: 926 (871 permanent and 55 temporary). These comprise: professional, 395; clerical, 158; technical, 373.

CONCLUSION

Relationships with other Government Departments, the University of New Zealand and its constituent colleges, the Cawthron Institute, and other research organizations and industry generally have been most cordial.

It is a pleasure to record my sincere appreciation of the efficient and loyal service rendered by all members of the staff of the Department throughout New Zealand.

F. R. CALLAGHAN, Secretary.

REPORTS FROM BRANCHES

AGRONOMY DIVISION

Director: Mr. J. W. Hadfield

FUNCTIONS

The Agronomy Division, at Lincoln, is responsible for improvement in field and vegetable crops (exclusive of wheat-breeding), and approaches this objective by pure-line seed-production, plant-breeding, and plant-introduction.

PURE-SEED PRODUCTION

The pure seed raised by this Division from single plant selections is taken over by the Department of Agriculture, the Canterbury Agricultural College, or by selected merchants; sometimes it is for further increase, but the bulk is for distribution by the Department of Agriculture under a system of seed certification.

The Division maintains stocks of the following agricultural seeds for distribution:—

Wheat.—S.S. Tuscan, Tainui, College Hunters, Hunters II, Dreadnought, Cross 7, Hilgendorf, W.R.I. Yielder, Marquis, Fife Tuscan, Jumbuck.

Oats.—Gartons Abundance, Algerians, Duns, Binder, Achilles.

Barley.—Chevallier, Spratt Archer, Golden Archer, Plumage Archer, Culture 9, Newal, Wong, Pioneer, Prefect.

Ryecorn.—Black Winter, N.I.A.B.

Garden Peas.—Onward, Greenfeast, English Wonder, Little Marvel, Greencrop, William Massey.

Field Peas.—Harrisons Glory, Mammoth White, Mammoth Blue, White Prolific.

Linseed.—Cheyenne, Rio.

Linen Flax.—Russian Seln. II, Russian Seln. III, Liral Crown.

Brassicas.—Calder swede, T.H. kale, chou Moellier (giant), chou Moellier (medium), giant rape, B.L.E. rape, club-root-resistant rape.

Lupins.—Sweet Blue, Sweet White, Sweet Yellow, Bitter Pink.

Lucerne.—Strain B (New Zealand certified).

Pasture Species.—Clovers: Broad red, Montgomery, white. Grasses: Short-rotation rye, Italian rye.

PLANT INTRODUCTION

A vast amount of material introduced from overseas is either under observation or under yield trial, and much of it is being used in crosses—*e.g.*, S172 oat with very stiff straw is used to give resistance to lodging. The barley varieties Kenia and Maja are useful parents in producing a barley suitable for direct heading. Many of the linseed and linen-flax varieties are highly resistant, and some even immune to the races of rust present in New Zealand. Some useful material, particularly of lupins, has been obtained from Germany.

A close watch is maintained on overseas literature, and through personal contact with workers overseas it is possible to obtain valuable material for trial and breeding.

BREEDING AND SELECTION

Oats.—The main difficulty experienced in the growing of oats in Otago and Southland is the lodging of the crop, and two crosses, Resistance × Onward and Resistance × Algerian, are now in F11 and are being grown in replicated trials at the Division and

in the field. Further crosses with the stiff-straw Welsh variety S172 are in various stages of development under observation and selection. While Onward is a very important milling oat in New Zealand, it is segregating for type to an extent that prevents its certification. Selection within this variety to obtain uniformity is being undertaken.

Barley.—The main project aims at the production of an improved variety suitable for direct heading. Kenia, Maja, and Culture 9 have been crossed with Spratt Archer and Golden Archer, and this material now in F4 will be grown next year for the first time to measure yield and quality. Research is an introduced variety that has assumed a dominant position in Canterbury during the past season, but it has the serious disadvantage of segregating into several maturity groups, which detracts from the malting quality of the grain. These maturity groups have now been separated, and the selection of one or more uniform lines of Research barley is well under way.

Ryecorn.—The N.I.A.B. winter ryecorn has proved at Lincoln and Gore to be superior to any other cereal green feed, and at least twice as productive as the commercial ryecorn usually grown in this country. Extreme variations in type within the variety offers scope for further selection being made during the vegetative period.

Peas.—From crosses between William Massey and Greatcrop an effort is being made to select an early variety with a yield heavier than that of William Massey. An attempt is also being made to improve the Onward variety by crossing it with Greenfeast, William Massey, and Greencrop. Efforts are being directed to the improvement of Partridge peas by selecting for smoothness, earliness, evenness, and wilt resistance from crosses between Partridge and the wilt-resistant variety, Marathon. Further improvement is being sought from crosses between Greenfeast and Blue Prussian in the production of a satisfactory boiling pea.

Lupins.—Two strains of the white-seeded, low-alkaloid variety, Weiko, homozygous for non-shattering, have now been obtained. In these selections there is no pre-harvest loss due to shattering, yet they offer no difficulty in threshing. Now available in sufficient quantity for field trial is a bitter pink-flowered strain which, when spring sown, exhibits marked superiority in rapidity of growth over the commonly grown bitter blue-flowered lupin. Crosses between this pink-flowered strain and the white-flowered sweet variety have been made in the hope of obtaining a sweet lupin of more rapid growth than any at present available.

Rape.—The club-root-resistant strain is proving extremely popular, particularly in Southland, where farmers who had previously given up growing this crop on account of club-root are now finding it possible to grow the new strain, and are obtaining high yields. Rape is extremely susceptible to aphid attack, and a more resistant plant is being sought in the hybrids between rape and aphis-resistant swede.

Kale.—The strains of chou moellier raised at this Division show up with advantage when compared with imported lines. A promising hybrid between giant chou moellier and thousand-headed kale has been increased for large-scale trials next year. Many other hybrid types are being grown, and chou moellier has been crossed not only with thousand-headed kale, but also with spring and winter cabbage and with kohlrabi. Some hybrids give heavy yields of leaf at seasons when the standard varieties have passed their peak. There appear to be great possibilities in the breeding of kales.

Swedes.—The variety Dryland, which was raised by the late Director of this Division, Mr. R. A. Calder, has been renamed Calder Swede, as the term Dryland proved far too restrictive. The variety has proved to be extremely hardy, resistant to aphis attack, and more resistant to mottled heart, dry rot, and club-root than any other variety. A large quantity of seed is now being distributed by the Department of Agriculture.

Potatoes.—It has been possible to increase a number of varieties imported from United States of America, England, Scotland, and Germany; to make a number of crosses; and to test out some hybrids that were already available. It is proposed to extend this work to include resistance to blight, virus disease, frost, and drought, as well as improving yield and quality.

Linen Flax.—Selection is being carried on with the rust-resistant varieties R1, R2, and R3, aimed at the production of rust-immune strains with improved fibre yield. The possible effects of minor elements, boron, molybdenum, manganese, and zinc on the yield and quality of fibre are being investigated. Drought was unfortunately the cause of last year's trials being unreliable.

Linseed.—Rust has proved so devastating that no variety is safe to grow unless it is at least highly resistant to this disease. It is unfortunate that some varieties resistant to rusts in North America have proved to be susceptible to the rusts found in New Zealand, but some are proving satisfactory. In co-operation with the Plant Diseases Division it is hoped shortly to have material available that will be not only resistant to rust, but will also give satisfactory yield and percentage of oil in the seed.

Vegetable Research.—The vegetable research section is engaged in testing a wide range of varieties and strains of vegetables as a preliminary to breeding and seed-production. Special attention is being paid to outdoor tomatoes, broccoli, savoy cabbage, spring cabbage, and onion. Overhead irrigation has made it possible to carry out these tests in a district with very limited rainfall, and has proved without doubt the vast increase and the improvement in quality that can be anticipated under irrigation. It is hoped to extend these investigations to several parts of New Zealand.

GENERAL

Weed Control.—Trials at this Division have revealed certain information as follows:—

(*a*) Pre-emergence sprays are too much affected by weather conditions to give reliable results, and are therefore not recommended.

(*b*) Low-volume spraying both with D.N.O.C. and with hormone sprays gives as good results as high-volume spraying, and at a much lower cost of application. Great care must be taken, however, that the correct amount is applied per acre.

(*c*) Time of application may be critically important in the spraying of linen-flax crops. The present indications are that the fibre is less likely to be damaged if the crop is sprayed when 2 in. high than at any later stage.

New materials are constantly coming to hand. Some have given promising results in preliminary trials, and these are being continued.

GRASSLANDS DIVISION SUBSTATION

The Grasslands Division Substation is carrying out trials, mainly with the grazing animal, to test under Canterbury conditions various strains of pasture species bred or selected at the Grassland Division's headquarters in Palmerston North. Digestibility trials are undertaken in co-operation with the Agronomy Division to compare winter green feeds. Some work is being done on seed-production problems, and the turf advisory service to aerodromes in the South Island is being continued.

PLANT CHEMISTRY

A branch laboratory of the Plant Chemistry Laboratory, Palmerston North, has been established here to undertake chemical investigations likely to be of assistance in evaluating fodder crops, and breeding material developed by this Division.

ANIMAL ECOLOGY SECTION

Officer in Charge: Dr. K. A. Wodzicki

The establishment of the Animal Ecology Section was approved by Cabinet on 17th July, 1948. The first meeting of the Animal Ecology Research Committee took place on 17th November, 1948. The Committee includes the following representatives: Dr. R. A. Falla (Royal Society of New Zealand), Professor B. J. Marples and Mr. F. R. Callaghan (Council, Department of Scientific and Industrial Research), Mr. A. P. O'Shea (Federated Farmers of New Zealand), Mr. W. J. McGibbon (South Island Acclimatization Council), Mr. K. R. Allen (Marine Department), Mr. D. A. Campbell (Soil Conservation and Rivers Control Council), Mr. W. C. Barry (Department of Agriculture), Mr. C. M. Smith (State Forest Service), Major G. F. Yerex (Internal Affairs Department), Mr. P. McLean (North Island Acclimatization Council), and Dr. W. M. Hamilton (Department of Scientific and Industrial Research).

The survey of introduced mammals was completed by the end of 1948. It is intended that the survey should be published as a departmental bulletin. This bulletin will include the sixteen mammals surveyed in the original cyclostyled report completed in 1947, as well as the survey of the remaining thirteen introduced mammals completed in 1948.

A preliminary field survey of bird damage in orchards of the Nelson district was completed. A summary of Mr. Peter C. Bull's work on the feeding habits of the blackbird in the Auckland area was prepared, and a paper for publication will be completed shortly.

At its first meeting the Animal Ecology Research Committee approved the general policy that attention should be concentrated on the rabbit problem, first priority being given to a detailed study of the biology of the rabbit. In order to select a suitable experimental area (following the approval by the Animal Ecology Research Committee of the Section's research programme), Hawkes Bay, North Canterbury, and North Otago have been inspected. This field survey also provided an opportunity of studying various aspects of the rabbit problem in Hawkes Bay.

In collaboration with the Botany Division, a report was prepared on rabbits and their effect on the vegetation of Mount Highfield, Waiau. A report on the effect of rabbit poisoning on game-birds was also prepared, in collaboration with the Dominion Laboratory. One member of the Section began an Honours thesis this year at Victoria University College on the parasites of the rabbit.

A number of specimens of various predatory mammals were collected during the year and the skins preserved. This material and other data will in due course be a useful basis for a taxonomic study of these species.

Two members of the staff took part in the Fiordland Expedition. The collaboration of Dr. Olaus J. Murie, scientific leader of this expedition, will be of great value to the future work of the Section. The Seventh Pacific Science Congress provided an opportunity of meeting several wild-life experts and ecologists from Australia, Canada, and the United States of America, and of discussing problems of common interest. The possibility of some prominent ecologists visiting New Zealand again, and the exchange of personnel, were also discussed.

AUCKLAND INDUSTRIAL DEVELOPMENT LABORATORIES

Director: Mr. J. B. Brooke

With the arrival of more equipment from overseas, and the securing of slightly more space, the final establishment of the laboratories is in sight. The Electrical Test Laboratory should be set up within three months, and the Tinsley potentiometer installed and calibrated. A start has been made on the Mechanical Test Laboratory, which is now available for a limited range of work, although there is likely to be some delay in obtaining the 50-ton Universal testing-machine.

Industrial servicing and development work has accounted for the major portion of the year's work, and a brief description of a few of the more important projects should serve to illustrate the wide variety of problems that have been dealt with during the year.

The Physical Section has suffered severely from lack of staff, and it has not yet been possible to secure the services of a competent metallurgist. Assistance in metallurgical problems is being made by regular visits from metallurgists attached to the Dominion Laboratory and the Dominion Physical Laboratory.

Newspaper-wrapping Machine.—Work on this prototype machine continued throughout the year, and two major development difficulties arose.

(*a*) Adhesion of wrappers was too slow to permit ejection of wrapped papers immediately after rolling.

(*b*) The wrapper roll feed mechanism gave unsatisfactory performance in service as it required constant adjustment.

The first difficulty was overcome by adding a pressing stage to the machine, and the second is at present being solved by redesigning the wrapper feed. Trials of the machine at New Plymouth gave a best run of 1,200 wrapped papers in slightly over half an hour.

Brush-making Machine. –This machine, designed to produce plastic-set artists' brushes at a speed of five a minute, was built during the year, and has completed preliminary running tests successfully.

Breathing-apparatus for Respiratory Cases of Poliomyelitis.—A rough prototype of this apparatus was constructed for the Auckland Hospital, with the use of surplus aircraft parts. The apparatus has now been redesigned and remade as a permanent piece of equipment.

Skin-temperature Measuring.—This equipment has been constructed for recording the body temperatures of infants under anæsthesia.

High-speed Counting and Packing Machine.—Designed and made for a manufacturer of crown seals, this machine has two counting heads which alternate in counting and delivering 100 gross of crown seals to cartons.

Acceptance and Performance Tests of Machine Tools and Equipment.—Equipment has been made for the testing of machine tools to Schlesinger limits, and considerable work has already been done both for manufacturers and importers of new and reconditioned machine tools. The testing of industrial products such as fans, pumps, &c., also comes within the scope of this section.

There has been a marked increase during the year in the amount of work involving testing and calibrating to standard specifications, and it is expected that this work will increase still further as a wider range of equipment is secured.

Equipment is at present being completed for the rapid multiple testing of watt-hour meters for the test-room of the Auckland Electric-power Board.

Air-sampling Equipment.—In conjunction with a local consulting analyst, equipment has been manufactured that will sample the air in the vicinity of the industrial area at Westfield. Wind direction and time will be recorded coincidently with the analysis of the air.

Soil Shear Test Machine.—An improved model of the original machine has been constructed and tested, and in this model individual loading pumps are employed on the axial and shear loads.

GENERAL

A considerable amount of work has been carried out in determining the characteristics of motors, alternators, fluorescent tube ballasts, transmission lines, and I.F. transformers. A distortionless A.C. voltage-stabilizer has been constructed for substandard meter testing.

Work was continued on the prevention of frost damage in Auckland orchards by the use of horizontal fans. Without a great deal more meteorological data, little can be said at this stage about the effectiveness and reliability of fans for the prevention of frost damage to crops in Auckland. However, for given meteorological conditions a fair estimate of the performance of this type of fan has been obtained.

Further records have been secured in the investigation into air-conditioning of greenhouses, and it was thought that it would be possible to issue a report on the design requirements from an engineering standpoint. It is evident, however, that plant physiologists must first be able to supply critical and optimum conditions for plant growth before this can be done.

A prototype pulse-rate recorder has been designed and constructed. After slight modifications, some most interesting records were obtained during major operations at the Auckland Public Hospital and Green Lane Hospital. It is hoped to combine this equipment with the blood-pressure-recording equipment at present being developed at the Dominion Physical Laboratory, so as to provide a valuable piece of equipment for the control of anæsthesia and the early indication of dangerous trends in the condition of the patient.

BIOMETRICS SECTION

Officer in Charge: Mr. I. D. Dick

Completed Projects.—The following projects have been completed and are being prepared for publication:—

(1) The design and analysis of asymmetrical factorial designs suitable for use in animal nutrition.
(2) The application of confluence analysis to agro-economic surveys.
(3) The accuracy of reversal trials in dairy experiments.

Other Investigations.—Work has also been done on the analysis of the distribution of yellow-leaf-diseased plants in *Phormium tenax* plantations, but further data are necessary to complete this project.

An attempt has been made to apply the methods of probit analysis to study the growth curves of *Phormium tenax* plants, but this work has been discontinued indefinitely owing to difficulties in interpreting the results.

An investigation has also been made into the accuracy of the point analyser when used to determine secular variations in vegetative cover. Preliminary results have been obtained from data collected in the South Island, and at the moment a theoretical attack is being made that shows considerable promise.

Work in Progress.—This falls into two major categories: (*a*) the theory of systematic sampling, which is a problem of very real importance in such fields as forest surveys, ecological studies, and kindred fields; and (*b*) the theory of the statistical analysis of time series—a problem of fundamental importance in numerous geophysical problems.

General.—The advisory duties are still heavy, but the location of assistant biometricians at Auckland and Lincoln is a considerable advantage in this respect.

The development of the section is proceeding satisfactorily. The nucleus of a good library has now been established, staff training both in New Zealand and overseas is under way, and punched-card computing equipment has been ordered and is coming to hand.

BOTANY DIVISION

Director: Mr. A. L. Poole

The Director, Dr. H. H. Allan, retired at the end of 1948, and a new Director and Assistant Director were appointed at the beginning of 1949. The total staff is now twenty-four. One member attended the meeting of the Australia and New Zealand Association for the Advancement of Science, in Hobart, and afterwards visited a number of places in Australia; a London University graduate, on two years' post-graduate botanical work in New Zealand under a Goldsmith's Scholarship, has been attached to the Division; and one member of the staff is on two years' advanced cytological work at the John Innes Institute of Horticulture, London.

TAXONOMIC BOTANY

The flowering plant and seaweed herbaria have been reorganized, and are now in good working-order. Substantial additions of specimens, including a number of water plants, have been made, bringing the number of sheets in the former to 62,000. The minute flowering plant *Wolffia* has been found in New Zealand. Exchanges with overseas herbaria have been increasing over the past year or two.

Special studies on the detailed taxonomy of New Zealand *Leptospermum*, *Agropyron*, and *Nothofagus* have been commenced or continued. In an experimental taxonomic study of *Agropyron scabrum* the breeding system and chromosome numbers have been determined and a knowledge of the ecotypes widened. This work is basic to the development of any tussock-grassland species for renovation of eroded areas.

Investigations on alien plants are being continued for the purpose of a revision of a previous publication by the Division, "A Handbook of the Naturalized Flora of New Zealand."

Extensive collections were made in part of the west coast sounds area—a locality rarely collected from by members of the staff who accompanied the New Zealand and America Fiordlands Expedition. Other collections were made in the region of Mount Hooker and Otoko Valley, South Westland.

Some 2,000 specimens were identified for outside botanists or organizations, a few from commercial firms necessitating close scrutiny of the taxonomic position of the species involved. A number of specimens of saffron thistle (*Carthamus lanatus*) and Mexican poppy (*Argemone mexicana*) growing in fowl-runs have been received for identification, and these indicate contamination of imported poultry grain.

ECOLOGY

Tussock Grasslands.—A full report on five years' work carried out on the tussock grasslands of Molesworth Station is almost ready. In connection with this work, studies of the scabweeds (*Raoulia* spp.), one of the key plants, have been continued. Investigations were extended to the St. Helens Station, which has recently been taken over by the Government and is to be run in conjunction with Molesworth.

Continuing on with the work of a Canterbury College graduate, plant sociological methods have been used to study the difference between four major tussock-grassland communities at Blue Cliffs Station, South Canterbury. It is hoped that a development of this work will pave the way for some method of extensive survey of the tussock grasslands.

Beech.—The 1948-49 season has been a prolific flowering and seeding season for *Nothofagus* in many parts of New Zealand. This has been studied in detail and measurements of seed fall have been made in a Wairarapa beech forest. Seed has been collected for reseeding experiments for the Nelson District Committee of the Soil Conservation and River Control Council. It appears that these heavy flowering years follow hot summers

Surveys. The vegetation and flora of the Reporoa Bog has been reported on, and a study of the vegetation and flora of the Ruahine Mountains is well under way.

Wild-life. A detailed ecological study of the feeding habits of wapiti (*Cervus elaphus*) in the Fiordlands has been made. The growth of the important duck-food plants, *Ruppia spiralis* and *Potamogeton pectinatus*, was observed under varying conditions. A brief survey of the food of a number of lakes and lakelets in the Manawatu area was made. The plant food of a considerable number of blackbirds was identified for the Animal Ecology Branch.

ECONOMIC BOTANY

Plant Introduction.—Over 160 introductions from twenty sources were made for the Divisions of this and other Departments. Sixty new introductions are being grown this year at the Division's experimental area, Waiwhetu. Some of the more important introductions include a collection of *Lotus* spp. for the Grasslands Division and grasses and woody shelter-belt species for dry conditions. Some of these woody species introduced two years ago have been distributed for trial. Seed from a number of introduced grasses has been distributed to Soil Conservation Council experimental areas.

Pollen.—A number of inquiries concerning hay-fever and the identification of pollens in bee loads have been dealt with by the Pollen Section.

Tussock Grasslands.—Further broadcast and line sowings have been made at Molesworth. Tall oatgrass (*Arrhenatherum elatius*) has been conspicuously more successful than any other species. Establishment of all species fails on denuded areas carrying only sorrel.

Seaweeds.—Records of the Marketing Department show that for the sixth year of agar production a new maximum (of 140 tons) of weed harvested was reached, of which the Wairarapa coast provided 77 tons. Information about agar and other seaweed industries in Australia was looked into during the year. Inquiries have been received about alginate-manufacture from big brown kelps.

Phormium. -As the result of the decision that phormium research is to be regarded as a long-range project, it has been possible to implement the work at the Moutoa Phormium Research Station. A solution must be found for yellow-leaf disease if the industry is to survive. Specialist officers have been placed on this work, and will spend most of their time at Moutoa. Satisfactory progress has been made on a re-survey of the vegetation on Moutoa, on breeding and genetical work, and on growth studies. Increased use is being made of SS (334) in breeding-work in an effort to secure plants resistant to yellow leaf. It has been decided to use the nucleus stocks of this variety for further planting on Moutoa. Increased vigour of growth is being obtained from selected third-generation selfed SS plants and from *P. tenax 301* × *P. colensoi 5*. Selected progenies of some varieties are being studied with a view to using these instead of clonal material for planting.

Vegetation surveys of Aickens area, near Featherston, and a phormium area at Otanemomo, in Southland, were made. A preliminary reconnaissance was carried out of an area in the Awakino Valley near Dargaville.

Forest-tree Dendrology.—Exotic forest trees are being studied with a view to building up a reliable herbarium. A particular study is being made of *Pinus radiata* and the natural variation of this species. It is hoped to be able to define types or strains. This work is being undertaken in the Nelson region for the time being.

Palynology.—The pollen slide collection of the Division can now be regarded as a national pollen herbarium available for reference on pollen taxonomy. The collection has been classified, and use of it is already being made by outside organizations.

The peat and lignite slide collection now contains 800 preparations. Examination of lignite samples from South Westland yielded what appears to be the first evidence of a mild interglacial period in New Zealand. A number of bogs were visited during the year and peat samples collected as well as the bog and swamp vegetation studied.

MISCELLANEOUS

New Zealand and America Fiordland Expedition.—A member of the staff assisted in the organization of the expedition and three members participated.

Artist.—The Division's artist has prepared illustrations for some ten different publications and projects, including such works as a series of poisonous plants, a seaweed bulletin by the Education Department, a publication on burrs by the Canterbury Chamber of Commerce, lichen articles, &c.

Cheeseman's "Manual of the New Zealand Flora."—The retired Director is undertaking the revision of Cheeseman's "Manual of the New Zealand Flora," last published in 1925. With the many changes that have taken place in taxonomic nomenclature since that date, there is an urgent need for the revision.

Exhibitions.—Phormium and seaweed exhibits were staged by the Division at the show held by the Hastings and Napier Branch of the Royal Society of New Zealand.

Seventh Pacific Science Congress.—One or other of the two sessions of this Congress was attended by most members of the staff and seven papers were presented.

Publications.—During the year publications by members of the Division were:

"Palynology in New Zealand." (*Svensk Botanisk Tidskrift, Bd. 42, H. 4,* 1948, pp. 472–3.)
"New Zealand Seaweeds." (New Zealand Education Department.)
"A Loose-lying Form of the Brown Alga *Hormosira.*" (In the press.)
"Fruit Characters of *Pittosporum dallii* Cheeseman." (*Trans. Roy. Soc. N.Z., 77,* Part 2, 1949, pp. 250–252.)
"Rata the Killer." (*Tuatara, I,* No. 3, 1948, pp. 36–38.)
"A Note on Lichens with a Key to the Commoner New Zealand Genera." (*Tuatara, I,* No. 3, 1948, pp. 20–35.)
"A Note on the Crustaceous Lichens of New Zealand." (*Tuatara, II,* No. 1, 1949, pp. 15–21.)
"The Flowering of Beech." (*N.Z. J. of Forestry, V,* No. 5, 1949, pp. 422–27.)

DOMINION LABORATORY

Director Mr. F. J. T. Grigg

During the year 1948 the Dominion Laboratory in Wellington and its branch laboratories (in Auckland, Christchurch, and Dunedin) continued to provide for the Government the manifold services that it has provided during the last eighty-three years. In addition, assistance to manufacturing industries has been rapidly extended, and preparations have been made to increase research work in a variety of fields, such as food technology, radioactive elements, and the chemistry of concrete.

In 1948 practically all sections of the work expanded in response to increased demands for service.

The number of separate samples examined in the Wellington Laboratory and in the three branches increased from 26,816 in 1947 to 31,677 in 1948. In addition to the work represented by the analysis of actual samples, there is a great deal of advisory and investigational work of which no indication is given in the sample numbers. This forms an increasingly large proportion of the total work of the Laboratory.

The table below shows the number of samples received during 1948 by the Dominion Laboratory and its branches:—

Contributor or Department.	Dominion Laboratory, Wellington.	Auckland Branch.	Christchurch Branch.	Dunedin Branch.
Agriculture	30	..	489	31
Air	125	10		
Army	22	1		
Broadcasting	6	..	..	..
Customs	114	18	8	28
Education	10	..	..	..
Food Controller	3	114	9	..
Forest Service	46	35	..	5
Health	5,742	6,479	6,454	3,266
Housing	184	97	2	1
Hydro-electric	113	24	1	..
Industries and Commerce	251	..	5	13
Internal Affairs	10			
Island Territories	6	..	..	..
Labour	2	..	..	2
Land and Income Tax	..	..	..	2
Land and Survey	2	10	7	..
Local bodies	18	36	1,238	172
Main Highways Board	128	..		
Marine	3	2	..	..
Marketing	9	406	2	27
Mines	1,274	..	..	2
Maori Affairs	25	..		
Navy	9	11	..	..
Plunket Society	304	56	92	62
Police	135	215	120	69
Post and Telegraph	70	9	3	3
Pottery and Ceramic Research Association	14			
Government Printer	4			
Prisons	154	..	..	..
Public Trust	..	..	..	1
Railways	39	4	25	46
Scientific and Industrial Research—				
Information Bureau	66	..		
A.I.D.L.	43	19		
Botany Division	..	..	..	..
Dominion Laboratory	138	10	11	38
Dominion Physical Laboratory	113	..	..	..
Geological Survey	188	..	5	2
Plant Diseases	207	763	..	
Plant Chemistry	3	..	..	..
Grasslands Division	..	..	..	3
Soil Bureau	7	..		
Fats Research	1	..	..	..
Industrial investigations	121	..	40	67
Unclassified	..	6	..	3
Standards Institute	7	..		
State Advances	83	148	14	
Stores Control Board	81	..		
Tourist	7	..	..	..
War Assets Realization Board	13	47	..	..
Works	114	49	5	16
Miscellaneous	646	2	13	14
Totals	10,690	8,571	8,543	3,873

ROCKS, MINERALS, AND CLAYS

Close collaboration with the Geological Survey was maintained. The Laboratory was represented on the Ceramic and Related Materials Research Committee, which also includes representatives from the Geological Survey, Mines Department, Industries and Commerce Department, Soil Bureau, and the Pottery and Ceramics Research Association.

Over 600 samples, including rocks, ores, clays, and miscellaneous inorganic materials, were received for analysis. Seventeen special reports and two information circulars were prepared. Glass-sands from nine localities were investigated and analyses and grading tests were carried out.

Work has been carried out on the New Zealand ironsands. The South Island black sands have been shown to differ from the Taranaki sands in containing separate magnetite and ilmenite instead of titanomagnetite. The Metallurgical Section is investigating new methods for the separation of titanium, vanadium, and iron from titanomagnetite. The Chemical Engineering Section has mechanically concentrated considerable quantities of black sand for the State Iron and Steel Department for use in the electric furnace smelting trials.

Diatomites for use as filtering agents in dry-cleaning were investigated. Tests were made of bentonites from several deposits. A new method of decomposing rocks for analysis, which may have industrial as well as analytical applications, was discovered and patented. Useful rapid methods for the analysis of clays and cements were developed and published.

FOOD, DRUGS, AND WATER

Preliminary surveys of the literature and discussions of fundamental problems in food technology were instituted, and the initial steps were taken in research into problems of the chemistry, dehydration, and transport of meat.

Very extensive analyses and investigations of all types of food as sold to the public were made for the Department of Health and other Government Departments. A few instances follow to show the general nature of this work. A number of cases were encountered in which foreign substances of different kinds were found in food. These included bread containing the body of a mouse and rodent excrement (several cases), and dried fruit and nuts containing insects. The resultant fines and publicity should do much to check carelessness in the handling of food.

In several centres checks were made on the quality of locally-produced egg-pulp. Bacteriological examinations were made of milk, milk-shakes, ice-cream, and egg-pulp. The results show that great benefit will be derived from an extension of this work.

Tin used for the tinning of food utensils was analysed to determine whether it contained excessive amounts of lead. Enamelled vessels were tested for the presence of lead, arsenic, and antimony. In bacon, boric acid was found to be much less prevalent than formerly. A survey of the alcohol content of liquors was made. "Sago" which has come back on the market was found in every instance investigated to consist of tapioca starch made in imitation of sago.

Special attention was given to the determination of vitamins in food. Analysis was made of large numbers of drug samples. Tablets of different kinds were defective, particularly in regard to uniformity of drug content.

The quality of public water-supplies was continually checked, both chemically and bacteriologically. A survey was made of the fluorine content of many town water supplies. The amount of fluorine present was in all cases so low as to be harmless. Whether this fact has a bearing on the incidence of dental caries is being investigated by the Department of Health with the co-operation of the Laboratory.

Milk-supplies throughout the country were closely watched by the Health Department. Experience shows that to ensure good supplies of pure milk a large amount of analytical control is essential. The Wellington City supply was again found to be of high

quality. Hawkes Bay supplies were rather unsatisfactory. The milk in several Auckland districts has continued to be unsatisfactory. A rather unsatisfactory state of affairs at Timaru improved after intensive sampling had been carried out. There was a marked improvement in the quality of milk supplied throughout the Otago district, and particularly in Dunedin, where the activities of the Metropolitan Milk Board and the effect of the new treatment plant are evident.

ORGANIC CHEMISTRY

This work was largely concerned with chemical problems undertaken for the State Forest Service. Determinations were made of resinous extractives from over 400 samples of *Pinus radiata* wood taken systematically at intervals through the season. In order to obtain relatively large quantities of extractives the solvent extraction of various zones of wood from whole logs of *Pinus radiata* was carried out. A commencement has been made with the quantitative separation of these resins into essential oils, resin acids, fatty acids, phenols, esters, and unsaponifiable material.

Complete analyses by recognized methods were made of some of the *Pinus radiata* wood samples, and of rimu, red beech, and tawa woods.

The crystalline resin, podocarpic acid, from rimu and white pine, which has certain structural similarities to œstradiol and œstrone, was reduced to podocarpinol. Preliminary physiological tests carried out by the Wallaceville Animal Research Station of the Department of Agriculture suggest that podocarpinol may possess the properties of an œstrogenic hormone.

A yellow crystalline aglycone, which has been named corymbiferin, was prepared from a yellow glycoside extracted from the roots of *Gentiana corymbifera*.

Ngaione, the main constituent of the essential oil of the leaves of the ngaio (*Myoporum laetum*), was studied and its structure partly elucidated.

TOXICOLOGY

Poisons detected in post-mortem specimens included barbiturates (7 cases), carbon monoxide (4 cases), morphine, nicotine, strychnine, digitalis, arsenic, cyanide, sodium nitrite, acetylsalicylic acid, aconite and belladonna (in a liniment), and a mixture containing acetylsalicylic acid, phenacetin, and codeine. Many examinations were made for alcohol in blood and urine.

OIL, BITUMEN, AND TAR

This work consisted mainly of the analysis of aviation fuel, petrol, and lubricants, and analyses and experimental work on bitumens, tars, and other roadmaking materials. A variety of problems in related fields were also investigated.

PHYSICAL CHEMISTRY

The amount of spectrographic analysis of metals has decreased since the end of the war. A semi-quantitative method has been developed for the examination of solder and lead. Spectrography was also used for the examination of minerals and rocks for minor constituents and rare elements, and for an approximate determination of some of the major constituents. It was also applied to the examination of paint and related materials in motor-collision cases, and in a burglary case.

X-ray crystallographic methods were applied to the identification of the components of boiler scales.

Analyses were made of electroplating solutions, and plated articles were examined on behalf of plating firms and assistance given in plating problems.

METALS AND CORROSION

Many examinations were made of metals by analytical and metallographic techniques. These were also applied to a variety of corrosion problems. Problems investigated included the galvanizing of steel spring washers, the corrosion of a cast-steel galvanizing-bath, the tinning of copper terminal lugs, the fracture of a coupling bolt in a hydro-electric generator, the season cracking of brass spray-pump containers, and the corrosion of water-spray guns. A large proportion of this work was undertaken directly for manufacturing industries.

COAL

More than 1,200 samples were received for analysis. These were mainly: 840 drill, 95 mine, and 72 outcrop samples of coal; 143 mine dusts; and a few samples of mine air and other gases. The survey work was continued in collaboration with the Geological Survey. For the Iron and Steel Department experimental cokes were made from blends of high-sulphur bituminous coals with non-coking low-sulphur Waikato coal. A classification scheme for coals based on calorific value, ash, and sulphur was determined. Considerable work was done on the washing of coal and on the inflammability of mine dusts.

Information derived from the work of the section is contained in twenty-six Coal Survey reports compiled during the year.

CHEMICAL ENGINEERING

The advisory work on fuel efficiency in industrial and local-body steam plants was continued. The installation, testing, and trial running of the experimental plant for the production of antibiotics at the Plant Chemistry Laboratory was completed. Further work was done on the curing of tobacco leaf. An investigation of the drying of hops was commenced. Other matters investigated included the packing of dehydrated apples, the bottling of apple-juice, and constant-temperature cabinets for insect research.

BUILDING AND CIVIL ENGINEERING MATERIALS

See under "Reports of Research Committees of the Council of Scientific and Industrial Research—Building Research."

GENERAL INVESTIGATIONS

Many analyses were made of insecticides. This involved a great deal of investigational work on methods of analysis of the new organic poisons and on the determination of traces of mercury. Grapes and tomatoes examined for residues of D.D.T. left after spraying in no case showed more than 7 p.p.m., which is the limit permitted by the Food and Drug Regulations. Apples sprayed experimentally with a selenium preparation to control red mite were found to retain not more than 0·5 p.p.m. of selenium. Analyses were made of timber impregnated at the Plant Diseases Division with boric acid, zinc chloride, arsenate, chromate, and fluoride respectively. Commercial timber, preserved with wolman salts, was examined by analysis. Some analytical work on moth-proofing of fabrics was also done.

Work was commenced on the optical properties of crystals.

SERVICE TO INDUSTRY

Much assistance was given to manufacturing industries, particularly in metallurgy, corrosion problems, food investigations, mineral resources, building-materials, and chemical engineering.

GAS TESTING

The gas-supplies of the four main centres and of most of the other main towns were regularly examined for calorific value, pressure, and freedom from sulphuretted hydrogen. All gas-meters put into service were tested and stamped before being passed for use.

PAPERS PUBLISHED

BRANDT, C. W. K., and ROSS, D. J.: "Podocarpic Acid as a Source of an Oestrogenic Hormone." *Nature* (1948), *161*, 892.

CHAMBERLAIN, E. E. (Plant Diseases Division), and CLARK, P. J.: "Investigations on Growing Pyrethrum in New Zealand II: Yield and Pyrethrin Content of Flowers." *N.Z. Jl. Sci. & Tech.* (1947), *29*, 215.

CLARK, P. J.: CHAMBERLAIN, E. E. (Plant Diseases Division): and PROCTOR, C. H. (Plant Diseases Division): "Investigations on Growing Pyrethrum in New Zealand III: Factors Influencing Pyrethrin Content of Flowers." *N.Z. Jl. Sci. & Tech.* (1947), *29*, 223.

DOMINION PHYSICAL LABORATORY

Director: Dr. E. R. COOPER

GENERAL PHYSICS

Frost Investigation, Hastings.—A field investigation into the atmospheric conditions accompanying frost in orchard areas was carried out in the Hastings area during the spring of 1948. In contrast to the work at Alexandra the previous year, the results suggest that fan installations might be of value in this district; the work is being continued during the coming Spring.

Measurement of Solar and Sky Radiation Received at the Earth's Surface.—Equipment is being developed that will automatically measure the spectral distribution of the visible and ultra-violet radiation received from the sun and sky at intervals throughout the day. Permanent observatory equipment is aimed at, the object being to obtain data for biological purposes year in and year out.

Domestic Water-heaters.—An investigation into the best designs of thermal insulation for domestic hot-water storage tanks has been used as a basis for the preparation, by the New Zealand Standards Institute, of a specification for such systems with a view to conserving electricity.

Tests on Synthetic-resin-impregnated Bearings.—These tests aim to determine the suitability of plastic-impregnated fabric bearings for control gates of hydro-electric power schemes. A machine has been constructed for measuring the coefficient of friction before and after prolonged working-conditions, which included immersion in water.

Tests on P.V.C. Overhead Power Cables.—The electrical and physical properties of P.V.C., and two other aerial cables in common use, are being compared under similar conditions of accelerated ageing.

Electron Microscope.—A laboratory for electron microscopy to serve all research workers in New Zealand has been established. Delivery was taken in the spring of 1948 of a commercial electron microscope from England, and it is now functioning satisfactorily. Lectures on the advantages and limitations of such an instrument and the special techniques used in the preparation of specimens have been given to most of its potential users, both within and outside the Department. To study these techniques, an officer of the Laboratory spent three months in Australia. Present indications are that the biggest field of work will be in the biological and medical sciences.

BUILDING RESEARCH

See under "Reports of Research Committees of the Council of Scientific and Industrial Research—Building Research."

INSTRUMENTATION

Blood-pressure Recording During Anaesthesia.—Equipment is being developed to record blood pressures of patients undergoing surgical operations under anæsthesia. Changes in systolic and diastolic pressures under these circumstances provide the surgeon with a means of determining the patient's condition, particularly with respect to the incidence of shock.

Frost Alarm.—To protect fruitgrowers from serious losses due to frosts, a reliable temperature alarm is required. The requirements present considerable difficulties in instrument design—*e.g.*, the alarm setting-point must be adjustable, the temperature-sensitive element should be installed in the orchard, while the instrument must give a visual indication as well as operate an alarm in a building some distance away, and the instrument must maintain its absolute accuracy to within $\pm$ 1°F., even though subjected to heat during the day. An electrical resistance type of thermometer is being developed, and will be subjected to exhaustive laboratory and field trials. Assistance has been given to two New Zealand firms experimenting with frost alarms; one of the devices will receive field trials during the coming spring.

Aero-engine Temperature Measurements During Flight.—Assistance was given to the Civil Aviation Branch, Air Department, by the construction and installation of thermocouples in an aero-engine cylinder, together with the recording equipment for it.

Meat Refrigeration.—Equipment was designed, constructed, and installed in a freezing-works for measuring temperatures and air velocities in an experimental freezing chamber, and temperatures at various depths of carcasses in a series of "deep freeze" investigations. Information has been received that data of considerable value and interest have been obtained from the trials.

NUCLEAR PHYSICS

Measurement of Radioactive Paint.—Equipment has been supplied to the Paint Section of the Department that will enable the quantity of paint removed by weathering or other process to be determined. The paint is rendered radioactive, and gamma ray counting equipment was designed and constructed to enable the intensity of radio-activity to be determined at any time.

Geiger Muller Tubes.—New designs of Geiger Muller radioactive particle-counters are being worked on, together with the associated electronic equipment required to operate them.

Laboratory Monitors.—These instruments have been designed for making rough checks on radioactive contamination of operators' hands, clothing, and working surroundings.

Pulse-generator.—This has been built to generate electrical pulses of various shapes and frequency simulating the pulses received from Geiger Muller counters. The pulses are used to check the performance of radioactive particle-counting equipment.

GEOPHYSICS

Magnetic Susceptibility of Rock Samples.—Laboratory measurements of the magnetic susceptibilities of rock samples are now a routine matter, and an extensive catalogue of such data is being built up to aid the interpretation of magnetic surveys.

Fluxgate Magnetometers.—Magnetometers for portable field use and for field bases are being developed with the use of a wartime invention known as the fluxgate principle. The method is particularly suited to a great deal of magnetic survey work, including rapid field surveys, continuous recording, and for measuring fast changes in the earth's magnetic field.

Permanent Magnetization Equipment.—Equipment for measuring the permanent magnetization of rock samples, to aid the interpretation of survey data, is under construction.

Electrical Conductivity Meter. -An experimental equipment is under test at Rotorua for measuring the electrical conductivities of thermal waters.

Schlumberger Well-logging Apparatus.—This enables electrical properties of rock strata to be determined by apparatus lowered down a borehole.

Calibration of Vibration Detectors. –A shaking-table for the testing and calibration of seismographs, geophones, and other vibration pickups has been designed. The table will be 2ft. square and will be capable of carrying instruments weighing up to 150 lb. The table can be given a horizontal or vertical motion of controllable amplitudes within the range 10^{-3} to 10^{-8} in. and of controllable frequency within the range 0·01 seconds to 10 seconds.

Embedded Strain-gauges.—Considerable importance is attached to the design of a new form of strain-gauge which can be embedded in a reinforced-concrete mass so that determinations of static or dynamic strain in large building structures, including dams, can be investigated. The Laboratory's attention has been directed towards the production of a unit of small size and high sensitivity, which would be sufficiently cheap to enable large numbers of gauges to be incorporated in a single structure. One promising type of gauge is at present under test; this gauge will detect a movement of approximately 1 millionth of an inch, corresponding to a strain of $2{\cdot}5\times10^{-6}$ approximately.

Geophysical Field Laboratory, Moore's Valley.—An urgent need existed for a non-magnetic building placed on a site free from electrical, magnetic, and vibratory disturbance. Such disturbances can arise from large trees, power electrification, strong tidal ocean currents on nearby coasts, &c. The greatest possible freedom from these disturbances is essential for the satisfactory testing of modern geophysical and seismic equipment. A site was selected at Moore's Valley, adjacent to Wainui-o-Mata, Wellington.

Oceanographic Research.—Opportunity exists in New Zealand for physical study of the surrounding ocean and sea coasts. Lines of investigations include measurements of the temperature and salinity distributions at and below the water surface, observations on tidal currents and their electrical and magnetic effects on coastal sites, measurements of the amplitudes and periods of waves arriving at the coast and their correlation with distant storm areas and movements. The latter study has immediate application to the tracking of storms and the forecasting of surf. Other problems concern wave action on harbour-works and coastal erosion and deposition. At the present time the serious study of physical oceanography is only just beginning in this country, and this year the Laboratory has made a start by constructing a simple form of wave-pressure element which may be immersed in the sea and connected to a recorder on shore.

ELECTRICAL, ELECTRONICS, AND ACOUSTICS LABORATORY

Portable Dynamic Strain-gauge Equipment.—The importance of strain measurements in building structures has already been mentioned. Resistance strain-gauges that may be readily attached to steel members are in common use, and work already conducted for the Ministry of Works indicated the need for equipment capable of recording simultaneously the dynamic strains indicated by a number of gauges. A multichannel cathode-ray oscillograph and camera with associated amplifier circuits, into which the output of six gauges can be fed, is being built for field use. Strain variations of frequencies up to 200 cycles can be recorded.

Wool Medullometer. The hairiness of a wool staple is observed by immersing the staple in benzol, which is of such a refractive index that only the hairy fibres are visible. An estimation of the hairiness can be obtained from the light reflected by the hairs, and this light is measured by a photo-electric cell. The development of a meter working on this principle was completed this year, and equipment handed over to the Massey Agricultural College.

Ultra-violet Integrators.—Three integrators which will automatically record the total ultra-violet radiation from the sun and sky have been completed. These instruments are intended for making a rough comparison of the ultra-violet radiation received in any three districts in New Zealand during the same season. The spectral distribution of the radiation cannot be determined by this type of instrument (that aspect of the subject is referred to in the section on General Physics).

Quartz–crystal–controlled Clock.—At the request of the Dominion Observatory, a quartz-crystal-controlled electric clock has been built to operate from a battery supply. Economy of valves and supply consumption was a prime consideration. The 100 kilocycles per second crystal frequency is converted down to 50 cycles per second, driving thereby a commercial phonic motor clock and a time-pip switch.

The clock is undergoing trials, which so far have proved satisfactory. It is not at present expected to have sub-standard accuracy or stability, since neither the crystal nor its thermostat are of highest quality. Its timekeeping quality can be improved by the substitution of a high-grade crystal and precise thermostatic control.

Quartz-crystal Preparation.—At the request of the Post and Telegraph Department, modern methods of finish grinding quartz-crystal plates are being investigated with the object of improving local manufacture in accordance with the more stringent international frequency agreements shortly to come into force.

The various techniques involved include lapping, etching, electroplating, and x-ray irradiation. The initial work accomplished has aimed at establishing a satisfactory method of observing crystal performance.

Wenner Strong-motion Seismograph.—This seismograph, which was obtained from the United States of America at the instigation of the New Zealand Institution of Engineers, is installed at the Dominion Observatory. It is designed to give a high-speed record of the dominant frequencies of vibration experienced during earthquakes. Since the recording paper necessarily moves quickly, it is necessary to initiate its movement only at the onset of the disturbance. The trigger mechanism that was provided to do this was found to be inadequate, and an alternative mechanism was devised which has proved satisfactory.

Mental-therapy Electric-shock Unit.—The conventional shock equipment in New Zealand is capable merely of applying an adjustable mains frequency voltage between a pair of electrodes for a predetermined period. An alternative treatment, known as the "brief stimuli" treatment, involves the application of a chain of short pulses instead of an alternating voltage. The Department of Health asked for the development of suitable equipment, and a prototype is at present under construction.

Magnetic Amplifiers.—Investigation of this modern type of electrical amplifier is being directed towards a method of amplifying low-current low-impedance outputs – for example, of thermocouples. A simple circuit has been built which amplifies direct currents of the order of 50 microamperes, but temperature instability prohibits higher sensitivities.

Radiography Timer.—The Department of Health requested the design of an automatic exposure timer for use in x-radiography and photofluorography. In the latter case a photo-multiplier cell lens system is directed at the fluorescent screen and the associated circuits integrate the light energy received, automatically terminating the exposure when sufficient light has been received by the camera. In the case of x-radiography, the fluorescent screen is illuminated by the rays after their passage through the photographic plate.

RADIO LABORATORY

Radar Hut.—The development of a system embracing a base equipment and a number of hut sets was requested by the Tourist Department for alpine resorts. The initial requirement stated that only in some emergency was the communication system to be used, and on this basis tests were carried out in the Hermitage area, using 470 kc/s. The utility of the system for routine communication in order to help to prevent emergency conditions was soon recognized, however, and this would necessitate the use of a frequency removed from the international distress band. The prototype equipment was modified to operate at 3,180 kc/s., and successful trials were carried out across the Tararua Range.

At the instance of the Post and Telegraph Department, the hut equipment prototype has been modified to permit its supply either from a hand-driven generator or from storage batteries. Both the hut and base prototypes have been handed over to the Post and Telegraph Department, which will arrange the manufacturing contracts.

Radio-wave Investigations.—Preliminary measurements of the variation of absorption on the path between Awarua and Wellington have been carried out. An approximate correlation between these measurements and vertical incidence ionosphere absorption measurements, previously carried out at Christchurch, near the mid-point of the path, showed a discrepancy. A new series of measurements is now being prepared, in which the oblique and vertical absorption will be observed simultaneously.

The object of this work is to improve the accuracy of predictions of usable frequencies on short paths within and about New Zealand. It is being investigated with the approval of the Radio Research Committee, and both the Post and Telegraph Department and the National Broadcasting Service are interested in the results.

Microwave Propagation Tests.—Equipment held on loan from the Admiralty is suitable for the determination of the transmission characteristics of visual paths at 30 cm. and 3 cm. wave-lengths. It is intended to make use of this to commence an extended operational trial of a path across Cook Strait from Island Bay to Blind River, near Seddon.

Radio Research Office.—A central office for the collection and correlation of radio research information has been set up in the Carter Observatory building. Some useful work has already been carried out in the correlation of radio performance figures with predictions and with indices of ionospheric and magnetic disturbance. Detailed analyses of short-term forecasts produced by the Director of the Carter Observatory showed that these were statistically a little more successful than those of the Services' Observatories. The office provides routine ionospheric frequency predictions for local services required by the Navy and the amateur radio organization.

RADAR LABORATORY

Canterbury Project.—After the completion of the field-work, a remnant of the staff commenced to prepare the results for publication prior to their being analysed theoretically. The analysis will best be done at T.R.E. in England, and provisional arrangements exist for two of the staff to be seconded there. The work has been delayed by staff difficulties, but is now progressing satisfactorily.

Microwave Meteorological Radar M.E. 1.—Of the four equipments that have been manufactured, two are now installed at Whenuapai and Nandi. The Whenuapai equipment is giving very satisfactory results, balloons being followed to 80,000 ft. in altitude and up to 130,000 yards in range. Installation at Tahiti is in progress.

Subsidiary Meteorological Radar.—The Meteorological Service has expressed a requirement for a small number of subsidiary stations of lower performance than the M.E. 1 above, to supplement the coverage of upper wind information in New Zealand.

Some tests have been carried out with equipment working on 1·5 metre wave-length, to give range and bearing only up to 10,000 ft. altitude and 10,000 yards range. These tests were unsuccessful; further tests with Army searchlight control radar will be made before this wave-length is discarded. Possible alternatives would be based on surplus airborne radars using 10 cm. or 3 cm. wave-length.

Vehicle speed Indicator. An apparatus for observing the speed of road vehicles has been made at the request of the Transport Department. This employs the Doppler principle as affecting radio waves. A beamed aerial fed by a continuous-wave 3,000 mc/s. oscillator is directed along the road; the outgoing energy is reflected by a moving object and thus returns with a slightly different frequency. The difference between outgoing and incoming frequencies is a direct measure of the speed of the reflecting object, and is presented as a meter reading. The equipment has been handed over to the Transport Department and is giving satisfactory service.

Radar type "Henry." This is a high-discrimination 3 cm. radar with characteristics closely approximating the requirements laid down for merchant marine navigational radar. A number of equipments are on loan to the Department from the United States Navy.

In addition to that already fitted in the t.s.s. "Tamahine," a second set has been lent to the Anchor Shipping Co. and fitted in the t.s.s. "Matangi," and a third set has been installed on the top of Mount Victoria overlooking Auckland Harbour. The latter set will give useful information and experience of the utility of harbour radar in New Zealand.

METALLURGY

The major portion of the time of this section is spent on servicing work for industry and Government Departments. This covers advice on the heat treatment of ferrous and non-ferrous metals for machinability, the melting and refining of metals, physical and metallographic analyses of metals, including x-ray examination, and the suitability of metals for various engineering applications. Visits have been made to a number of foundries and workshops.

Ironsands.— One research officer has been engaged on full time in preparing for the large-scale trials that are shortly to be held at Onekaka by the Department of Industries and Commerce. The work has covered the preparation of 120 tons of ironsand from Patea and 6 tons from Gillespie's Beach, South Westland. A magnetic separator previously designed and built by the Laboratory for experimental work was used to prepare a portion of these trial samples of sand. The sand from Gillespie's Beach was suggested by the Laboratory as being worthy of trial, since it had been reported by C. O. Hutton some years ago that this particular sand had a low titanium content.

Lead Reclamation.—The present high price of lead has caused several battery-manufacturers to ask for the development of a furnace suitable for the reclamation of lead from used batteries. Initial trials with a preliminary design of furnace have given good results with a very high percentage recovery of lead. A final prototype furnace is under construction.

ENGINEERING RESEARCH

Hydraulic Model Investigations.—These investigations are being conducted for the Ministry of Works. Tests on the Maraetai spillway at 1/50 scale are completed and have been very worth while in assisting design. Tests on the Cobb River spillway at 1/48 scale are nearing completion, and here also the tests have led to a modification of design which gives improved flows.

Heat-pumps.—Investigations have been made into the possibility of using heat-pumps in a number of commercial and industrial applications, and the laboratory is urging the use of heat-pumps as compared with ordinary methods of heating in a number of civil and commercial undertakings with a view to conserving power. A small pilot plant has been constructed from which direct experience of the method can be gained.

Strain-gauging on Engineering Structures.—Dynamic strain-gauge tests were made for the Ministry of Works on a bridge near Napier. Continuous records were taken of bridge vibrations as a heavy load was driven across the bridge at various speeds. Experimental results showed evidence of resonance at truck speeds of 25 and 50 m.p.h. and gave a close correspondence between the observed and calculated natural frequency of the bridge. Similar tests were made on a reinforced-concrete girder bridge at Paremata.

DESIGN

River-stage Recorder.—A prototype recorder is under construction for the Rivers Control Council for providing a continuous record of river-levels in remote locations. The instrument will measure river-level changes of up to 60 ft. to an accuracy of 1 per cent. of recorded depth.

Hardboard Experimental Plant.—Satisfactory samples of hardboard have been produced from Southland beech and pinus. The latter wood appears surprisingly easy to manipulate.

Mobile Drilling-rig.—This equipment has been under test in Southland. Faults have been corrected and the drill is now operating successfully.

Sound-film Modulator.—The sound-film modulator was designed and built for the National Film Studios. It is essentially a light valve for recording sound on film by the variable area method.

Molecular Still.—In 1946 the Laboratory designed and built for an Auckland firm a high-vacuum short-path molecular still, which has since been successfully used for the commercial extraction of vitamin A from fish oils. A second still for the same firm to the same general design, but incorporating a number of improvements, was built during the year.

Fractionating Molecular Still.—This is a new type of molecular still, and uses a specially shaped condenser rotating in conjunction with and close to the inner surface of a cylindrical evaporator on the inner surface of which the distilland flows. This design should give a much greater fractionating efficiency than other types, and provisional patents have been taken out. An experimental model is being built.

Seismographs. A number of seismographs of the Wood Anderson type were designed and built during the year for installation at the Seismological Observatory, Apia, and at stations in New Zealand.

Magnetic Tone Wheel.—This instrument, which is to be used for measuring speed fluctuations in sound-recording equipment, was completed for the New Zealand Broadcasting Service.

Pilot-balloon Timer. The Meteorological Branch of the Air Department asked for a timer that would give an audible signal for five seconds every one or two minutes. This was designed and built, and is being used for timing observations by radar or visual methods on pilot balloons.

Vehicle Volume Counter. A counter that records the number of vehicles passing along a road was designed and built for the Transport Department. The record consists of a paper tape on which is printed, at half-hourly intervals, the total number of vehicles that have passed over a rubber tube stretched across the road.

Ultracentrifuge.—This equipment will be used by the Plant Chemistry Laboratory of the Department for studying the molecular weights of proteins and other substances. It consists of an air-driven turbine with a maximum speed of 60,000 revolutions per minute. A rotor is attached to the turbine and holds samples of the substance to be studied. The optical system is of the " Schlieren " type and photographic records will be made. The equipment is now being built in the workshops.

Travelling Grid Intervalometer.—This instrument, for timing camera exposures in aerial mapping-work and at the same time compensating for varying terrain, has been delivered and tested, with very satisfactory results.

Multi-chamber Incubator.—The incubator consisted of ten insulated chambers which were maintained at evenly spaced temperatures between 0° c. and 50° c. It has been installed at the Entomology Division's substation at Ashburton.

Sun Camera.—A camera has been designed and built for the Carter Observatory for recording sun-spot activity.

High-speed Dental Drill.—The object has been to produce a dental handpiece running at a speed of 50,000–60,000 revolutions per minute, as such a handpiece would improve considerably present methods of drilling. Considerable mechanical difficulties have been overcome, and a demonstration unit is being prepared.

Vibration Activator.—This machine is for applying alternating loads of varying amplitude and frequency to the earth or to buildings. It will be used initially by the Geophysical Survey, but will have considerable application in research into the vibrations of structures.

STANDARDS LABORATORY

Instrument Calibrations.—During the year, sixty statements of examination were prepared on account of about one hundred instruments. The majority of these instruments are in use by Government Departments and public bodies. A few of them are high-grade substandard instruments.

Standard of Temperature Measurement.—Whilst waiting for the filling of the main overseas order for temperature apparatus, the various fixed-point equipments are being prepared. Provision is now being made for the following points: ice, steam, sulphur, silver, and gold, and also antimony, tin, carbon dioxide and mercury. A precision water bath is nearly ready for service. A large number of our present Standard thermometers are undergoing calibration in Australia.

General Metrology.—A large number of both internal and industrial measurements and calibrations has been dealt with. In addition, the section has designed and installed nine earth-pressure-measuring equipments for the State Hydro-electric Department's Lake Tekapo works, has made an extensive series of measurements on small racks and gears, and has made running deflection tests on a well shaft for a textile firm. The final checking and reduction of the pendulum gravity survey (1947) has been almost completed.

Electrical Standards.—The basis of electrical standardizations in New Zealand remains the same as previously—*i.e.*, on groups of Standard cells and resistances brought in from overseas. This foundation has been consolidated during the year by providing the addition of new individuals to the reference groups and by arranging the permanent housing of the Standard cells.

Various special power supplies for metre calibration have now been in operation for some months and have greatly increased the availability of the D.C. standards of measurement.

A.C. work is very difficult to do on account of the poor power supply available, and information is being sought on stabilized electronic equipment to replace the existing sine-wave alternator.

The Equipment Section, from which serviceable, calibrated electrical apparatus is loaned out to other laboratories, continues to perform a very useful function.

WORKSHOPS

The Laboratory Workshops consist of a tool-room, instrument workshop, sheet-metal workshop, electrical workshop, fine-instrument workshop, glass workshop, and cabinet shop. During the year, the tool-room has supplied a large number of special tools and gauges to New Zealand industry. Machines have been installed for the production of moulds for plastic and die-cast products, and this service is being fully used by manufacturers. The instrument workshop has been engaged in making up many

of the instruments described under the heading of "Design Section." The fine-instrument workshop and the electrical workshop have carried out repairs to a number of mechanical and electrical instruments for industry and Government Departments. In addition to the above, all workshops have carried out their major task of providing workshop facilities for the laboratories, thereby materially assisting the progress of the various research projects described above.

ENTOMOLOGY DIVISION

Director: Dr. D. Miller

GRASS-GRUB

Insecticides.—The use of insecticides against larvæ and beetles has been studied. No satisfactory results have so far been secured against larvæ with D.D.T., benzene hexachloride, chlordane, pentachlorphenol, or sodium pentachlorphenate. On the other hand, 6 lb. lead arsenate in 14 gallons water per 1,000 square feet of turf gave control and allowed recovery of the grass without injury to it. Control of grubs was secured in strawberry-beds without injury to the plants by the application of lead arsenate at the rate of 10 lb. to 1,000 square feet.

Against adult beetles, low- and medium-volume spraying of pastures and gorse hedges was carried out, using D.D.T. and benzene hexachloride at various concentrations.

In general, the low-volume spraying gave poor results on pasture that had been heavily grazed during November and December. On the other hand, medium-volume spraying gave good control, increasing with the strength of insecticide. Work is progressing on areas of dense pasture.

Results on sprayed hedges were good in early stages, but rapid growth caused the late flights of beetles to be not affected.

Consolidation of Pasture.—The influence of rolling was studied, and it was found that (under the conditions of the experiment) this was less effective in consolidating the soil than the influence of trampling by sheep.

Irrigation.—The influence of grubs has been studied on pastures that have been under irrigation for three years: under these conditions no damage to the pasture was apparent although the grub population was found in places to be as high as 40 per square foot. In co-operation with the Agriculture Department, an experiment has been laid down to ascertain the influence of irrigation on the infestation of pasture by grass-grub (and caterpillar).

Biology.—Important data have been secured from investigations into the flight periods of beetles in relation to physical conditions, the duration and extent of flights, mating habits, and the effectiveness of light traps and fires. In the last, for example, it was shown that 2,000 males could be trapped without a single female, the highest percentage of females in any light trap being only 24 per cent., and the percentage was usually much lower. This indicates that fires are of little value in controlling the egg-laying females.

Parasites.—Cultures of the nematode parasite are maintained on grubs in the soil, but nothing further can be done until the necessary equipment is available.

The bacterial "milky disease" brought from America has been liberated in an experimental area, and is being studied.

Four native insect predators have been reared from grass-grubs, and what influence they might have on the grass-grub position is being studied.

In the search for parasites in Australia considerable progress has been made, and during the year sixteen consignments, comprising 8 different species and totalling 2,500 individuals, have reached New Zealand in excellent condition, fully 90 per cent. of the insects surviving the journey. These parasites all attack the Australian grass-grubs, but recent studies in Australia have revealed a locality where a parasite of adult beetles occurs in considerable numbers.

The parasites received from Australia were studied in the laboratory, while others were liberated in the field. Three species at least were found to attack the New Zealand grub in the laboratory, and so far one species has developed through to the adult insect. Under natural field conditions also, at Ashburton, this species has successfully developed; as it has been liberated under a wide range of habitats, later observations on its development will be of very great value. Though the work is yet in its initial stages, the progress has been very satisfactory.

GRASS-CATERPILLAR

In a search for substitutes for bran for use in poison baits, experiments are being carried out with vegetable oils, vitamin-rich substances, &c. Toxic agents were paris green, D.D.T., and benzene hexachloride. The results are not yet finalized.

Another series of experiments giving promising results was with the use of superphosphate with which D.D.T. and benzene hexachloride were incorporated.

WIRE-WORMS

Owing to damage to wheat, oats, lupins, and turnips by wire-worms, experiments with various insecticides were carried out, but no clear evidence of control resulted. The species of wire-worms involved is being studied.

CRUCIFEROUS CROPS

As time allowed, injuries to cruciferous crops by aphids, diamond-back moth, and white butterfly were investigated.

STORED-PRODUCT INSECTS

Toward undertaking an authentic knowledge and control of stored-product insects in New Zealand, a survey of the position has been undertaken; so far 96 collections from various products have been made and over 30 species of insects recorded.

CODLIN-MOTH

Studies of the flight period during the season show that the moth is on the wing from the beginning of November until mid-March, and that two peaks of activity occur, one in December and the other at the end of January. Observations were also made on the habits of the moth and larvæ and duration of the stages. There were no indications of there being more than one generation during the season.

MANUKA BLIGHT

Detailed attention has been given to this problem, and study has been made of the insects involved, including their distribution, periods of activity, and influence upon the vigour of the manuka. It is yet too early to evaluate the experiments to determine the part played by insects in the death of scrub.

SAND-FLIES

An investigation of the sand-fly problem in New Zealand has been undertaken to ascertain the most active species, their places of breeding, range of flight, and possible methods of control.

TIMBER INSECTS

Observations commenced some six years ago have been continued on the influence of preservatives upon timber borers. Valuable data have been secured on the reaction of larvæ and beetles to the different preservatives at higher and lower concentrations.

GREEN-VEGETABLE BUG

This bug has become a serious vegetable pest in the North Island and its control by parasites has been undertaken. A survey of the position resulted in Paihia (Bay of Islands) being selected as the most suitable place for the work to be carried out. Supplies of egg parasite (*Microphanurus basalis*) were secured from Australia and successfully reared and distributed. There are several generations of the parasite each year. From the 300 to 400 parasites imported, supplies totalling 23,900 were built up and distributed over a wide area where the bug occurs—North Auckland Peninsula, Bay of Plenty, and New Plymouth district. The biology and ecology of the bug and the parasite were also studied.

GENERAL

A great many specimens were handled for identification, various Departments, public bodies, farmers, and private individuals were given advice on insect-control, and several papers on the year's work have been prepared for publication.

(See also Cawthron Institute investigations.)

FATS RESEARCH LABORATORY

Director: Dr. F. B. Shorland

BUTTERFAT INVESTIGATIONS

From the lengthy triplicate ester fractionation analysis of two-monthly samples of butterfat there is gradually emerging a detailed picture which shows, *inter alia*, (*a*) that the most marked differences occur in the C_{18} unsaturated acids as between May (29·6 mols. per cent.) and November (22·1 mols. per cent.): (*b*) that, subject to normal climatic conditions, the fatty-acid composition of butterfat of any given month will exhibit no marked changes for the corresponding month of another year: and (*c*) that there is absence of correlation between the fatty-acid composition and the physical properties, which suggests that a complete explanation of the properties of butterfat requires a knowledge of glyceride structure. As a basis for glyceride structure, however, it is first necessary to know accurately the fatty-acid composition as well as the properties of fully saturated glycerides; progress has been made in these studies.

Investigations on the nature of the unsaponifiable matter of butterfat have led to the isolation of pure crystalline β-carotene. In addition, four other compounds were separated, and are in the process of being identified. In collaboration with the Nutrition Research Department of the Medical School, University of Otago, unsaponifiable extracts are being prepared by different methods to investigate further the nature of the vitamin D activity, which from previous work may be several times greater when measured on the whole fat as when measured on the unsaponifiable matter.

INVESTIGATIONS ON TALLOW

An improved method of stearic-acid manufacture based on short-path vacuum distillation of the crude fatty acids has been developed. A pilot plant is being constructed by the Chemical Engineering Section of the Dominion Laboratory to demonstrate the advantages of the method, which reduces the loss of tallow fatty acids from 15 per cent. to 3 per cent.

FISH-OIL INVESTIGATIONS

Contrary to the prevailing opinion, the removal of free fatty acids by alkali refining was found to increase the vitamin A potency of fish-liver oils approximately in proportion to their free fatty acid content. Papers dealing with the results of this work have been

prepared for publication. A comparative study of the digestion of shark livers, with water and with dilute alkali respectively, showed that dilute alkali yields more oil with higher vitamin A potency without adversely affecting the rate of deterioration of vitamin A in storage.

In accordance with a request from the Marine Department, the German "Eiweiss" process of making an albumen substitute was tested, and it was found feasible to convert shark flesh into a satisfying product as judged by baking tests.

MISCELLANEOUS

Of considerable theoretical interest is the work on the depot fats of the horse. In contrast to depot fats of sheep and cattle, horse fat contains considerable proportions (*ca.* 20 per cent.) of octadecadienoic and linolenic acids, which are major components of pasture glycerides. A paper on this subject is being prepared.

Technical advice has been given on various matters relating to oil and fat technology.

Early this year the Director went to Australia to accompany a British Mission which had been sent to study the beef industry.

FRUIT RESEARCH STATION

Director: Mr. J. D. Atkinson

A new branch, known as the Fruit Research Station, was formed in October to take over from the Plant Diseases Division the investigation of fruit problems other than those of disease. Investigations formerly controlled by the Fruit Research Officer have also been transferred to the new organization. Fruit Research has temporary headquarters with the Plant Diseases Division in Auckland, and outlying research orchards at Oratia (Auckland), Havelock North (Hawkes Bay), Appleby (Nelson), and Earnscleugh (Otago). A block of 24 acres under grass has been purchased in Havelock North for development as future headquarters.

Fruit storage investigations, carried out for some years in Wellington, have been drastically reduced, because a further attempt to make the semi-commercial store gas-tight was unsuccessful. Additional modifications are not practicable as the main framework of the store has decayed.

New buildings and equipment obtained for the outlying orchards have considerably improved facilities for field experiments. Development work has proceeded rapidly at Earnscleugh, and trees available are now carrying a full programme of experiments.

POMOLOGY

A new series of woolly-aphis-resistant rootstocks, from dwarf to very vigorous, has been received from East Malling, England. New trials of rootstocks for peaches and Japanese plums were planted at Oratia, and trials of stocks for apricots and English plums were set out at Earnscleugh.

After extended trial, six new apple varieties of English origin have been released to the New Zealand Fruitgrowers' Federation for commercial trial. Five peach varieties, selected from sixty introduced from Australia in 1940, have also been released.

A preliminary trial of commercial hormones for preventing pre-harvest drop in apples demonstrated significant differences in efficacy. Foliage was damaged by any preparation containing 2, 4–D. An officer has been appointed to investigate hormone effects on fruit, with the ultimate objective of extending the certification scheme to cover these substances.

PHYSIOLOGY

Work has continued on artificial freezing of apricot buds and blossom. Last season's results were partially confirmed, and it was demonstrated that at critical temperatures the percentage of wet blossoms killed was much higher than that of dry. Measurements of inversion ceilings, development of frost alarms, and tests of fans against Auckland winter frost were continued by the Dominion Physical Laboratory and the Auckland Industrial Development Laboratories.

Preliminary trials with chemical thinning and new wound dressings were made. These are sufficiently promising to warrant extension.

There are strong indications that green-crinkle of apples is caused by a virus, and extended trials to clear up this point are in progress.

STORAGE

Small-scale tests with refrigerated gas storage of Granny Smith apples over two seasons indicate that the most satisfactory storage conditions are within the following limits: carbon dioxide, 6 per cent., oxygen 5 per cent. to 10 per cent.; temperature, 38° F. to 39° F. A preliminary trial with Chinese gooseberries showed that these could be held for six weeks at 31° F. to 32° F. without detrimental softening. Effects of manurial treatment on storage quality of apples were similar to those reported in previous years. There were marked differences between varieties, but, in general, applications to trees of nitrogen alone caused a deterioration in storage quality of the fruit, while a combination of nitrogen, phosphate, and potash gave a quality comparable with that of untreated fruit.

MANURIAL TRIALS

Long-term trials at Appleby again showed that a combination of nitrogen, phosphate, and potash gave greater production than any of the materials applied singly. Differences between varieties noted in previous reports were maintained.

MISCELLANEOUS

An acetylene-operated mechanical bird-scarer was imported and tested in a cherry orchard. When combined with shooting it appears to offer practical assistance with the bird problem, and trials will be continued.

(See also Cawthron Institute research.)

GEOLOGICAL SURVEY

Director: Mr. M. Ongley

The staff of the Geological Survey was strengthened by the appointment of young geologists, some of whom came from overseas. The sudden death, however, of Mr. E. O. Macpherson created a most serious gap in the senior staff, for this officer had a wealth of knowledge of the minerals of New Zealand. A regional office, covering the Auckland and North Auckland area, was established under the control of a superintending geologist. A district office was opened at Napier.

The field-work in the Kaikoura Subdivision was completed. Further field-work has been done in the North Auckland, Rotorua, Napier, Canterbury, and Southland areas; a preliminary geological survey was made of a portion of the Waipapa Dam site; and the Atiamuri Dam site was mapped in detail.

A member of the staff accompanied the Otago School of Mines Expedition to Stewart Island to report on possible economic minerals. A full report has not yet been made.

In the economic and engineering geology field, a preliminary survey was made of the black sand deposits north of New Plymouth. Investigations were made on the occurrence of manganese at Clevedon, asbestos at Takaka, slate at Oamaru, bentonite, and other minerals. Assistance was given in the collection of materials for the trials on electric smelting of ironsands. Bridge and dam sites were examined for the Ministry of Works and local bodies.

COAL

Work was done in four coalfields—Invercargill, Mataura, Balclutha, and Greymouth and plans were prepared for work at Huntly, Ohura, and Mokau. This included the mapping of the extent and structure of the fields, correlation of the seams, and estimation of the quantity and quality of the coal.

With the limit of our coalfields becoming better known, the fuller utilization and further supplementing of our supply grow more urgent. Recent work shows that there is no workable coal in the coal-measure of west Southland along the south-east of Fiordland. To prove the extent of the lignite that can be worked, open-cast drilling was commenced in Mataura. In Kaitangata, recent work indicated that the coalfield does not extend beyond Tuakitoto in the west and Taratu in the north. Murchison has been re-examined, and no new coalfields found. The coal in the Garvey Creek field has been estimated, and Reefton is being examined. Heaphy, Karamea, and Collingwood have been re-examined.

In the search for limestone suitable for dusting the coal-mines, the limestones of the West Coast have been examined. Seams, mines, and drill cores are being systematically sampled.

VOLCANOLOGY

The collection of data on temperature, composition, acidity, pressure, and flow of water and steam from bores and natural vents has continued.

Observations were carried out at National Park when Ngauruhoe erupted on the 30th April, 1948, and again on the 8th February, 1949. On the 9th February lava flowed at intervals from the crater and reached to within 50 ft. of the flats at the foot. Many *nuées ardentes* accompanied explosions during the first two weeks. On the 28th February only small quantities of steam issued from several small vents in the debris-filled crater, but on the 5th March the crater was deepening again, and had a small patch of new lava in the bottom.

Geophysical measurements have been made to determine the best sides for drilling for hot water in the Wairakei area. Tests have also been carried out on the use of geophysical methods in prospecting for areas for development of thermal power.

HYDROLOGY

Water-supply problems have been investigated, particularly in Canterbury, where important results have been obtained. Geophysical methods have been used to determine the depth to the ground water on the Canterbury Plains in the hope that the position of the main water-table, and any perched water-tables that might be present, could be defined.

PALÆONTOLOGY

Fossils have been identified for the field geologists. In order to survey the coal resources more efficiently by distinguishing the coal-seams, a start was made on the study of palæobotany and spores. Micropalæontological research has continued on oraminifera and on their importance in stratigraphy.

PETROLOGY

The Petrology Section has continued to give valuable service to the field geologists, Government Departments, and the public. Aggregates have been examined for reactive materials. A paper, "The Emplacement of the Bluff Norite—a Re-interpretation," was written, and it gives the first application of granitization in New Zealand.

GEOPHYSICS

The purchase of a gravimeter during the year marked an important event in geophysical prospecting in New Zealand. Gravity surveys will supply basic data badly needed in the interpretation of structural geology in its relation to scientific and economic problems. Gravimeters are widely used in the search for oil structures in other countries.

Magnetic and seismic methods were used for the investigation of Atiamuri Dam site. The vertical magnetic intensity was measured at approximately a thousand stations, and a magnetic map compiled. This revealed a dominant elliptically-shaped anomaly pattern which has its origin at depth, and it was later identified as being due to the presence of a rhyolitic dome. To elucidate the effect of the surface material that is of primary engineering interest, it was necessary to isolate this anomaly pattern from the total observed magnetic effect.

The Taupo Town Board's hydro scheme at Hatepe River was investigated by the same methods. A buried river-channel to the north of the present stream was located, and its general trend outlined.

Prospecting by the State Hydro-electric Department at Waipapa revealed that the Waikato River eroded through the ignimbrite sheet on which it was intended to anchor the dam structure. Initial tests by seismic methods disclosed that such discontinuities may be located by seismic studies.

Pakotai Copper Deposit.—The Pakotai copper deposit was studied by electric methods, and magnetic observations also covered the surrounding area. The results of this survey confirmed the existence of the already known ore-body, but did not suggest its extension in any direction.

Thermal Area, Tikitere.—Investigations into the thermal area at Tikitere are connected with the general scheme of ultimately utilizing natural heat for power-development. Tikitere is considered to be a suitable type locality for these studies. The application of the magnetic method disclosed low magnetic values in areas of past and present thermal activity. The Tikitere results suggest that the magnetic method may be useful in locating altered rocks at depth and give a lead to the existence of high-temperature steam below the surface. Preliminary electric studies reveal that the electrical conductivity is considerably greater over active than over non-active areas.

Foundation Problems.—Problems of foundation connected with the proposed establishment of a State saw and paper mill were undertaken in the Murupara area. Arrangements were made with the State Forestry Service to purchase additional equipment to make it possible for the survey to investigate natural frequency responses of soils to which it is intended to anchor the industrial units.

GENERAL

The Director represented New Zealand at the eighteenth International Geological Congress in London in August, 1948, and at the British Commonwealth Conference on Geology and Mineral Resources in September, 1948. Whilst overseas he also investigated the Italian scheme for utilization of natural steam for power at Larderello.

A revised geological map of New Zealand and a booklet, "The Outline of the Geology of New Zealand," was published.

GEOPHYSICAL OBSERVATORY, CHRISTCHURCH

Director: Mr. J. W. Beagley

As a result of the reorganization of the observatories of the Department, the Geophysical Observatory, Christchurch, now integrates the activities of the Apia Observatory and the Ionospheric Observatories at Lincoln, Rarotonga, and Campbell Island, as well as developing cosmic-ray research, undertaking statistical work on the magnetic records from Amberley, and maintaining climatological observations in Christchurch.

ACCOMMODATION, BUILDINGS, GROUNDS, ETC.

More commodious offices for the new branch were obtained in Christchurch.

The new Ionosphere Observatory at Rarotonga, Cook Islands, was completed early in the year, while the Lincoln Recorder building and the Apia Observatory buildings have been kept in good condition.

INSTRUMENTAL

Apia

Time Service. With the exception of the Knoblich chronometer, all clocks have given a satisfactory performance. The winding-chain on the former slipped and the chronometer was returned to New Zealand for repairs.

Terrestrial Magnetism.—The standard cells of the magnetograph calibration apparatus were damaged in April, 1948. Two Daniel cells were constructed and used until the new Weston cells were received and installed in November. The scale values as determined with the locally made Daniels were much the same as those obtained with the more reliable Weston cells. Some trouble was experienced with the variometer recording clocks and it was necessary to run these with improvised escapements. Only a few days record were lost.

Seismology.—The installation of a short-period Wood-Anderson seismograph in November greatly increased the value of Apia as a seismological recording-station. The Wiecherts recorded continuously, but their operation leaves much to be desired, and modern teleseismic instruments are urgently required.

Tide-gauge.—A new float well was installed early in 1949, as the one in use was badly corroded. The Lands and Survey Department again checked the level of the staff zero with reference to the Mulinu'u Bench Mark. Three hydrometers were received in 1948 from the United States Coast and Geodetic Survey and these are to be used in measuring sea densities.

Ionosphere Recorders

Rarotonga.—A new manual recorder was installed early in 1948 by a member of the Dominion Physical Laboratory. The equipment has operated satisfactorily since it was installed. To decrease the possibility of losing records because of power-supply failures, an additional 5 kW. Hill Diesel generator was placed in operation, as well as another Pincor inverter set. In March, 1949, the aerial system was modified and the recorder overhauled.

Fiji. Consequent on a decision in the United Kingdom, the recording-station in Suva was closed down, and the equipment was returned to Christchurch.

Lincoln.—Because of wear in movable parts, the J. 28 recorder at Lincoln has required an amount of maintenance which tended to increase throughout the year. Adjustments made in March, however, effected a considerable improvement in its operation. A 5 kW. Hill Diesel generator has been obtained and will be installed to act as a stand-by in the event of an A.C. power-supply failure.

Campbell Island. The manual recorder at this station has continued to give satisfactory service. A spare Briggs and Stratton alternator was overhauled and forwarded to the Island.

Research Station

Through the courtesy of the Army Department, buildings on a military area were made available for the establishment of a research station. A manual ionosphere recorder has been installed and operated. It is proposed to establish a recording fluxmeter at the experimental station for the purpose of correlating rapid changes of the earth's magnetic field with ionospheric and other associated phenomena.

RECORDINGS

Routine observational and recording programmes have been kept up to date at all stations. These include the absolute magnetic observations (weekly), determination of tidal heights, sea temperatures and densities (hourly), and the magnetograph calibration tests made at Apia (thrice weekly). Time signals have been obtained daily for rating of clocks. Measurements of magnetic hourly values obtained at Apia and Amberley, as well as ionospheric data from Rarotonga, Lincoln, and Campbell Island, are well forward. All measurements have been regularly circulated to other observatories and interested organizations. K-indices of geomagnetic activity and International Character figures have been forwarded monthly to the Carnegie Institution of Washington and the United States Coast and Geodetic Survey, while quarterly descriptions of magnetic storms recorded at Apia have been published regularly in the *Journal of Terrestrial Magnetism and Atmospheric Electricity.* Commencing January, 1949, the Amberley magnetic storm data has also been forwarded for publication.

During the year many earthquakes were felt locally with intensities ranging between one and four on the modified Mercalli Scale. Details of strong earthquakes were telegraphed to the United States Coast and Geodetic Survey. Now that the Wood-Anderson short-period seismograph has been installed, many more shocks within 5 degrees of Apia are being recorded. These were not being picked up by the Wiecherts, which are more suitable for teleseismic work.

Cosmic-ray Research.—The cosmic-ray meter of the Carnegie Institution of Washington has been operated continuously at Christchurch and data obtained therefrom forwarded regularly to Washington.

Six dozen Ilford nuclear research plates were obtained during the latter part of 1948 with the object of commencing a high-altitude cosmic-ray programme in New Zealand. The plates were distributed as follows: Mount Herbert at 2,997 ft.; Mount Rolleston at 7,250 ft.; Mount Ruapehu at 9,100 ft.; and Minarets at 9,700 ft. Some plates also were exposed between 25,000 ft. and 40,000 ft. in a Mosquito aircraft. All plates have been recovered and are being processed. Preliminary investigations indicate that a wealth of data on various disintegration processes caused by cosmic rays has been obtained, and this will be of value for comparison with the results of research workers in the Northern Hemisphere. Much time has been spent in developing the best recording technique with a microscope, and some success was achieved in photographing tracks from the plates for visual estimations. A Blackett intensity cosmic-ray recorder for the purpose of checking N–S and E–W effects is on order, and should arrive during 1949.

GENERAL

During the year the Director has made two visits to Samoa and one to Rarotonga for supervision purposes. The new scheme of staffing and operating the Apia Sub-Observatory is now well established and proceeding satisfactorily.

In 1948 two members of the Radio-Physics Laboratory of the Australian Council for Scientific and Industrial Research established an observing point at Leigh, North Auckland, to carry out investigations of "cosmic noise" phenomena. A member of the Geophysical Observatory staff assisted in this work and gained valuable experience.

Relief Post and Telegraph operators for the Campbell Islands were trained in ionospheric work, while the replacement ionosphere observers for Rarotonga and Campbell Island also received their basic training.

The following papers were prepared for the Seventh Pacific Science Congress:

Atkinson, H. R.: "A Survey of Sub-Antarctic Auroræ, 1941–46."

Beagley, J. W.: "Activities of New Zealand Geophysical Observatories at Christchurch, Apia, and Campbell Island."

Beagley, J. W., and Bullen, J. M.: "Trends in Magnetic Declination at Apia and Christchurch."

Beagley, J. W., and Stanbury, A. C.: "Preliminary Report on the Use of Photographic Emulsions for Recording Cosmic-ray Tracks at High Altitudes in New Zealand."

Gardner, A. L.: "Some Observations on 'E' Region Effects."

GEOPHYSICAL OBSERVATORY, WELLINGTON

Director: Mr. W. M. Jones

This Observatory, constituted as from 14th December, 1948, is concerned mainly with physical oceanography and with geophysics in relation to defence science. It is temporarily accommodated in the Dominion Observatory building at Kelburn, and recruitment of staff and collection of equipment are in progress. Preliminary activities have included the following:—

(1) Preparation for the installation of a fixed wave-recording station. Recently developed Admiralty equipment will obtain records of waves from pressure-variations on the sea-bottom, and analyse the records into wave-frequency spectra. The site will be just south of Greymouth.

(2) Development of portable units to be used for the recording of wave-systems as required at different parts of the coast-line under different weather conditions. One has been completed and a start made on the recording of waves at Island Bay, Wellington.

(3) Studies of microseisms in their relation to weather and wave conditions. Periods of dominant microseisms recorded at the Seismological Observatory, Wellington, have been found to average half of those of "significant" waves at Island Bay observed visually. Work is proceeding on the development of microseismic activity associated with the progress of cyclonic storms and the passage through Wellington of cold fronts.

(4) Work relating to some features of tides on the Wellington coast-line. It is found that considerable irregularities occur in the differences in times of high and low water as between Island Bay and Makara Beach. It is hoped later to relate observations of this type with measurements of current-systems in Cook Strait.

(5) Orders have been placed for two sea-surface recording thermographs and a bathythermograph, with the object of obtaining more detailed data on temperature distributions and variations in the waters surrounding New Zealand.

Applications of the above and other aspects of physical oceanography are numerous. They may be applied, for example, to the problems of mariners, the Defence Forces, marine biologists and fishermen, meteorologists, harbour and coast-protection engineers, &c. For many such problems the fundamental data are at present lacking, and it will be the task of the Observatory, as staff and equipment permit, to supply them.

GRASSLANDS DIVISION

Director: Mr. E. Bruce Levy

STAFF

Recruitment of both professional and technical officers has been below requirements.

Clerical services have been attended to satisfactorily despite staff shortage, but additional assistance is needed to cope with the increased work of both this Division and the Plant Chemistry Laboratory.

PLANT BREEDING

In addition to the synthesis of new strains, further improvement in various characteristics of strains already released into commerce is being continued. The pedigree strains so far produced are being tested at Palmerston North and at the Lincoln and Gore Substations in comparison with the best New Zealand ecotypes.

Recent developments in the plant-improvement programme are:—

Perennial Rye-grass.—Compared with the best North Island and South Island ecotypes, the pedigree strain is superior in persistency, sustained leaf-production, and resistance to leaf rust. It is, however, very susceptible to blind-seed disease, and attempts are being made to breed a strain resistant to this disease. Resistance has been shown to be inherited, but the resistant plants located are inferior agronomically to plants of the pedigree strain. By repeated back-crossing of resistant plants to susceptible plants of pedigree origin, further resistant plants have now been obtained which are similar agronomically to the pedigree strain. These plants are now being further tested for resistance, and will be used in attempting to breed a true-breeding resistant strain.

Western Wolths Rye-grass.—A small supply of seed of a pedigree strain has been produced and is being used for trials. The main use of Western Wolths rye-grass is for winter feed, and to be of value it would need to surpass Italian rye-grass in the early period after autumn sowing and maintain at least as high production through to the spring. In a pasture trial at Palmerston North the pedigree strain of Western Wolths has produced, in the first four months after sowing, 25 per cent. more dry matter per acre than Italian rye-grass, the figures being 1,856 lb. and 1,488 lb. respectively. This season the Agronomy Division is carrying out trials at Lincoln and Gore with this strain of Western Wolths in comparison with Italian rye-grass and various green-feed cereals.

Cooksfoot.—A leafy vigorous strain of cooksfoot has now been produced, and this year will be released to the Department of Agriculture for further trial, increase, and distribution under the seed certification system. In pasture trials at Palmerston North carried out over a three-year period this strain produced 20,350 lb. dry matter of cooksfoot per acre, compared with 17,184 lb. from the standard strain. At Lincoln during a two-year period the yields have been 6,720 lb. and 4,722 lb. for the pedigree and standard strain respectively. In seed-production trials carried out last season at Palmerston North, Lincoln, and Gore, the pedigree and standard strains were similar in seed yield.

STRAIN ECOLOGY

Measurement trials at Palmerston North, Lincoln, and Gore continue to show superiority of the Station's nucleus strains over selections produced overseas. In a three-year trial the Division's nucleus white clover has yielded a total of 24,000 lb. of dry matter, as against 19,000 lb. from the best overseas selection; and in the rye-grasses the New Zealand nucleus selection has produced 20,400 lb. dry matter, compared with the best overseas line at 14,400 lb.

Nucleus-seed production.—Sufficient nucleus seed of the more important species is being produced annually to supply stocks for admission into the higher grades of certified seed of perennial rye-grass, Italian rye-grass, short-rotation rye-grass, white clover, cowgrass, and Montgomery red clover. Nucleus timothy seed has been released this year, and a bred strain of Cocksfoot has been increased for release.

Sixteen years ago only 10 bushels of each of the rye-grasses and 100 lb. of each of the clover selections were available for growing on, but last year official figures show that 9,000 bushels of the rye-grasses and 8,000 lb. of the clovers were available for distribution to the seed trade as nucleus stocks.

A high percentage of the following certified seed (marked with asterisk) has originated from the Division's nucleus selections distributed over the past sixteen years:—

*Perennial rye-grass	1,015,804 bushels.
*Italian rye-grass	178,941 bushels.
*Short-rotation rye-grass	174,443 bushels.
Cocksfoot	469,317 lb.
Brown-top	563,939 lb.
*Timothy	6,725 lb.
*White clover	3,182,936 lb.
*Montgomery red clover	519,344 lb.
*Cow-grass	303,607 lb.
Subterranean clover	34,337 lb.

Seed Certification Tests.—The number of samples tested in field plots this year totalled 8,994, a slight decrease on last year's figure of 9,056.

Plant Introduction.—Many new species have been obtained from overseas through the services of the Botany Division. All these are being grown and studied at Palmerston North and other localities wherever possible—*e.g.*, coastal sand country at Himitangi, and at Te Awa in conjunction with the soil conservation experiments.

Pasture Plants in Relation to Soil Acidity.—Following a general experiment conducted in pots, in which a wide range of pasture plants were grown in soil at various acidities, the following points are at present undergoing further study:—

(1) White Clover: (*a*) Twenty different strains are being grown on plots of different acidity to see whether a special strain could be developed for acid soils; (*b*) a pot experiment is being conducted to check whether clover plants can change the reaction of a soil by their growth.

(2) Seed Germination and Establishment: A wide range of pasture species and strains have been sown in plots at different acidities to see what measures can be taken to establish desirable species under acid soil conditions.

PASTURE ECOLOGY

Influence of Clovers and Fertilizers on Pasture Growth and Composition.—The effect of clovers on pasture growth is more striking and impressive as the age of the plots increases. In the absence of adequate nitrogen—artificial or natural—no response to lime, phosphate, or potash has been recorded. On the other hand, in the presence of ample nitrogen, striking responses to phosphate have been measured.

An extreme range of pasture compositions and growths of grasses and clovers has resulted from various manurial treatments. The outstanding features of this trial are the widely differing responses to the various forms of artificial nitrogen.

Establishment of Clovers.—The effect of grazing and the resulting intensity of light reaching the clovers has greatly influenced the establishment of clovers in a mixed sward. More light means more clovers, especially where quick-growing grasses are sown with clover on highly fertile soils. The suppressing effect of the quick-growing grasses is more marked on white than on red clover. New trials have been laid down this autumn to extend the scope of the investigations.

Earthworms.—A study of earthworm habits and feeding shows correlation between weight of worms and herbage yield per unit area. Total worm weight per acre is about equal to weight of total sheep carried. Soil fertility appears to influence the species of worms present, and trials have been commenced to measure food ingestion of worms.

Pasture Management. These trials demonstrate the possibility of producing pasturage at seasons commensurate with the needs of the grazing animal.

SOIL CONSERVATION

Four officers of the Division are members of Catchment Boards. Pasture research to assist in soil conservation is proceeding in Manawatu, Rangitikei, Hawkes Bay, Wairarapa, and Poverty Bay Catchment Districts. Both wind-erosion and water-erosion problems are being investigated on several soil types and in different climatic zones at various altitudes.

In conjunction with the Soil Conservation Council, Catchment Boards, and Air Department, experiments in distributing seed and fertilizer on hill country by the medium of the aeroplane have been initiated with some success. Botanical analyses of some hill-country pastures have revealed that clover establishment, at or prior to time of top-dressing, is a prerequisite to a satisfactory response to aerial top-dressing distribution of fertilizers.

Te Awa Research Area

Gully-control Work.—During the year additional debris dams were constructed and maintenance work carried out on the existing constructions. Constant attention was necessary to maintain the "tailrace" of these dams, particularly after floods. In January exceptionally heavy downpours washed out the majority of the work. A detailed report has been prepared on the three years' work at Te Awa up to and including this period, and is in the hands of the Soil Conservation Council for publication. A new system of gully control has been started to replace the washed-out debris dams. It was considered that the catchment area and possible maximum runoff was too great on this particular soil type for the type of dam previously constructed. A bulldozer has been used to widen and level the gully floor, and the new waterway has been grassed.

Fifty-acre Block.—Botanical analyses to record pasture changes following oversowing and top-dressing have been carried out. Herbage-production measurements have been continued on the oversown pastures in comparison with the adjacent untreated country, and a great increase in production has been achieved—from one and a half ewes to four ewes per acre. Pedigree white clover, *Lotus major*, and subterranean clover have proved to be of outstanding value when oversown on the hills. The 50-acre area and most of the block is now space planted at five trees per acre.

Grazing-trial Area.—An additional area of 130 acres has been fenced into paddocks and a comprehensive research programme inaugurated. A preliminary trial has been carried out on the existing pastures and records kept of grazing figures, ewe weights, wool weights, and lamb weights on the various treatments. For pasture-production measurement, forty-eight frames have been made and placed on the area. Sward analyses have been undertaken periodically.

Bulldozed Tracks.—The two and a half miles of bulldozed track has proved troublesome because of the sandy nature of the subsoil, and consequently rill erosion has occurred, but control has been successfully carried out by fascining, sodding, and seeding.

SUBSTATIONS

Pasture research in its various phases has been extended into the Canterbury and Southland districts. The results from the Lincoln and Gore substations compared with those at Palmerston North indicate clearly that these stations are thoroughly justified. Reference was made earlier in this report to a few of the projects being investigated.

Cocksfoot-seed production trials have shown that nitrogenous fertilizer is economically important, whereas superphosphate only promotes a weed smother. Areas of various pastures treated with different fertilizers have now been sown to wheat to ascertain residual fertility effects. The influence of both red and white clover on grasses in mixed swards under different manurial treatments is being investigated.

HILL-COUNTRY OVERSOWING TRIALS

A fairly complete seed mixture has been oversown on hill-country pastures in the following districts: Poverty Bay, Hawkes Bay, Wairarapa, King-country, and Taranaki. In all instances the March and April sowings have been superior to those done at other seasons, but, in general, establishment has not been up to expectation. Counts of establishment of sown species have been recorded, and the difficulty in establishing them in hill-country pastures makes this an important feature in the Division's investigations.

GREENKEEPING RESEARCH

(In conjunction with the New Zealand Golf Association and the New Zealand Bowling Council.)

Routine research has been continued, and there has been some expansion in newer phases, especially weed control and rate of growth due to manurial treatments. Hormone weed-killers have been tested against the regular chemical weedicides with a diversity of results, which indicates that considerably more work must be undertaken.

An experimental bowling-green has been sown and planted with grasses and specific plants suitable for playing surfaces, but to date the establishment has been somewhat unsatisfactory.

Two conferences of greenkeepers were held during the year under review, and five diplomas in greenkeeping were awarded.

AERODROME ADVISORY SERVICE

In conjunction with the Ministry of Works, grass aerodromes are maintained to a high standard by officers of the Grasslands Division. During the year considerable aerodrome extensions have been undertaken as well as the restoration of the Gisborne aerodrome following the flood catastrophe last May.

Aerodrome surfaces are suffering owing to insufficient sulphate of ammonia fertilizer being available, and as a result of the shortage it has been impossible to grass some of the extensions to major aerodromes.

GENERAL

Pollen for Medical Institutions.—The service of supplying grass pollens to medical institutions for work on hay-fever has been continued. This season 852 grams were supplied.

Pasture in Relation to Phormium-fibre Production.—The experimental sowings on the Moutoa Estate are achieving the objects of controlling weeds and providing palatable grazing for stock.

Publicity.—A large number of written inquiries concerning pasture and turf problems, from overseas as well as from within New Zealand, have been dealt with, and several hundred visitors have been shown over the research areas. There has been an exchange of sample lots of seed with other countries, and this has resulted in a keen interest being shown in New Zealand's small seeds.

Officers of the Division are periodically called on to co-operate with other Government Departments, local bodies, and Education Boards in matters of grass establishment.

Members of the staff have given numerous lectures, and have prepared papers for various conferences and for publication in the *Journal of Science and Technology*.

Climatology.—Daily records at the climatological station have been made for and on behalf of the Meteorological Services, and both automatic and manual rain-gauges are installed at Te Awa in connection with hill-country pasture research projects.

INFORMATION BUREAU

Officer in Charge: Mr. N. A. Marris

PUBLICATIONS

The New Zealand Journal of Science and Technology.—There was a considerable increase in the number of papers submitted, particularly those dealing with agricultural subjects, and arrangements were made to increase the number of issues of the Agricultural Research Section from six to twelve per year, commencing with Volume 31 (June, 1949). Issues are still in arrears, but it is expected that these will be overtaken and the *Journal* brought up to date during 1950.

Bulletins.—In the Department's Bulletin Series, No. 95 ("Soil Erosion in New Zealand—Part I: Southern Half of North Island," by L. I. Grange and H. S. Gibbs) and No. 97 ("Report on Building and Civil Engineering Research in New Zealand," by Sir Reginald E. Stradling) were published. Others of this series (including "The Introduced Mammals of New Zealand," by K. A. Wodzicki) were prepared for printing. Two Geological Survey Bulletins were published: Geological Survey Bulletin No. 12 ("Reefton Quartz Lodes," by M. Gage) and Geological Survey Memoir No. 7 ("Otaki Sandstones," by R. L. Oliver). During the year a series of Information Bulletins was commenced: No. 1 ("Flue-cured Tobacco in New Zealand," by H. Thomson) was published, and No. 2 ("Tomato Diseases and Pests in New Zealand") and No. 3 ("Wheat Diseases and Insect Pests") were forwarded to the printer.

The scope of the *Industrial Bulletin*, published jointly with the Department of Industries and Commerce, has been widened to include contributions from the Department of Labour and Employment, the Industrial Hygiene Division of the Health Department, and the Standards Institute.

Miscellaneous Publications.—Other publications issued or in the hands of the printer were "Scientific Institutions in New Zealand," "Scientific Man-power Resources of New Zealand," "The Dominion Laboratory," and "Departmental Directory." This section has also continued to assist in the production and distribution of the two-monthly *Paint Review* and the quarterly *Agronomy Review*.

LIBRARY

The circulation of books, pamphlets, and periodicals from the library again increased considerably. All publications were classified under the Universal Decimal Classification. A mimeographed classified index to certain important journals for issue every month was commenced, but it was discontinued through lack of response. Short training periods were given at the Head Office library to librarians appointed to branch libraries.

TECHNICAL RECORDS

Technical documents increased to approximately 40,000 reports, and these were extensively used by the Services and industry. Index lists were circulated every two months, and from these about 1,300 requests were made for reports.

INFORMATION SECTION

Technical Information.—An increasing use was made of the information service by Head Office and by the industrial liaison officers in Auckland, Christchurch, and Dunedin. The number of major inquiries dealt with from various sources showed a considerable increase, which indicates that this service is appreciated in the primary and secondary industries.

Translations have been arranged as required.

Abstracts.—The number of abstracts requested through the service offered in the *Industrial Bulletin* was 550.

GENERAL PUBLICITY

Public Relations.—Frequent contact with the press has been maintained by arranging interviews for journalists and press conferences, and by the issue of special articles and notices to newspapers, magazines, and the Press Association. Supplementing this publicity from early in 1949, a regular series of press releases were sent to all the New Zealand newspapers, to a selection of the magazines, to overseas' newspaper representatives, &c., and a good coverage was obtained. Preliminary arrangements were made for a series of six broadcasts on the work of the Department, and for the loaning of technical films to interested organizations.

Displays.—Exhibits were staged at Dunedin's Centennial Industries' Fair (on the work of the Dominion Physical Laboratory) and at Christchurch (on the work of the Wheat Research Institute).

PHOTOGRAPHIC SECTION

The library of photographs was increased by approximately 1,000, and considerable use was made of the prints for both departmental and other publications. Cine films have been made of the models of the Cobb River hydro-electric scheme and of the plastic packing of frozen mutton. Other services have included Gestefilms, photocopies, lantern-slides, printing of microfilms, and general developing and printing for the branches.

Photographic Copying.—The reflex photographic process was used to copy 937 articles, ranging from 1 page to 400 pages.

WAR HISTORY

A separate volume is to be allocated to the Department in the official war history of New Zealand, and is to be entitled "Defence Science." Professor P. W. Burbidge has been appointed to write the volume, and has been supplied with the greater part of the background material. It is expected to be ready for publication within the next two years.

MAGNETIC SURVEY

Director: Mr. H. F. Baird

Terrestrial Magnetism.—The three types of magnetographs—Eschenhagen, Adie, and La Cour—were operated, and continuous records of the magnetic elements D, H, and Z were obtained. The weekly programme of absolute observations for base-line control was maintained. Local data of international magnetic character figures and K indices or the three-hour-range index of geomagnetic activity were forwarded regularly to Carnegie Institution, Washington, D.C., the Ionospheric Prediction Service, Department of Electrical Engineering, University of Sydney, Australia, and to the Carter Observatory, Wellington, until December, 1948.

Intercomparison of Instruments.—Arrangements were made through the Secretary and Director of the Central Bureau of Association de Magnetism et Electricité Terrestres for comparing the H instrument at Amberley with the International Magnetic Standard. In February, 1949, the Association's set of three Q.H.M.s (quartz horizontal magnetometers) were received by air mail from the Meteorological Institute, Copenhagen. Preliminary results indicate that little or no change has occurred in the Q.H.M.s at Amberley.

Magnetic Survey.—During the year further field-work was carried out, and twenty-eight magnetic stations were occupied on the mainland and six magnetic stations were occupied on the outlying islands. In April, 1948, the co-operation of the Aerodromes Branch, Ministry of Works, made it possible for observations to be made on the Auckland Islands and the Campbell Islands. Exact reoccupations were made on the

magnetic stations originally established in 1907 at Camp Cove on the Auckland Islands, and Perseverance Harbour on the Campbell Islands. A new station was established near the meteorological camp, and was called Vannevar Bush in honour of the Director, Carnegie Institution, Washington, D.C., from which institution the magnetic survey instruments are on loan. Last December two of the original magnetic stations on the Chatham Island, Te Roto and Waitangi B, were reoccupied, this being the first occupation since 1924.

Evidence on the results of an investigation into the effect of cargo on the aircraft compass of the Dakota air freighter which crashed near Point Rununder in September, 1948, was presented to the Board of Inquiry at Wellington. Magnetic survey data was supplied to the Marine Department for inclusion in the "New Zealand Nautical Almanac and Tide Tables."

The purchase of another electric calculator facilitated the completion of the reductions and computations arising out of the magnetic resurvey, and charts for all seven magnetic elements have been drawn in the Lands and Survey Department, Christchurch. A distribution has been made of the preliminary declaration chart of New Zealand for epoch 1945.5.

Seismology.—The Wood-Anderson and the three-component Galitzin seismographs were operated beneath the band-rotunda near Riccarton Road, Christchurch, with disappointing results. By arrangement with the Christchurch City Council the seismographs were removed and installed in the original cellar in the Botanic Gardens in February, 1949. Here the seismographs are giving greatly improved results.

Buildings.—Repairs and alterations were carried out so that the seismographs could be installed in the cellar in the Botanic Gardens. This work was not completed until February, 1949.

Equipment.—Magnetic survey instruments have been ordered from the United States of America and until this equipment comes to hand it will be necessary to retain the instruments at present on loan from the Carnegie Institution, Washington, D.C., for continuity of the survey programme to be maintained. An Askania vertical force magnetometer was transferred to this branch from the Geophysical Survey.

Staff.—Since the reorganization of the observatories in December, 1948, the staff establishment has numbered nine, two of whom are stationed at Apia.

Seventh Pacific Science Congress.—During the Congress the many visitors to this branch included Dr. Gutenberg and Dr. Richter, of Pasadena; Dr. Hodgson, of Ottawa; Dr. Berlage, of Batavia; Dr. Bayen, of Saigon; and Mr. Thyer, of Melbourne. At the Christchurch session of the Congress members of the staff gave geomagnetic papers, and another member read the translation of a paper for a French author.

OCCUPATIONAL PSYCHOLOGY RESEARCH UNIT

Director: Mr. D. Straker

The work of the Industrial Psychology Division was greatly reduced, partly owing to loss of trained staff, and partly by the transfer of responsibility for industrial servicing and vocational advisory work to the Personnel Advisory Division of the Department of Labour and Employment. The Christchurch office was closed at the beginning of May and its records transferred to the Wellington office.

The sole remaining investigator did a considerable amount of travelling as a member of the Aircrew Selection Board of the R.N.Z.A.F. Apart from this, his time was fully occupied with his duties as Secretary to the Consultative Committee on the Scientific Man-power Resources of New Zealand: the report of this Committee was published in December. A start was then made on a survey of the use of psychological tests in New Zealand.

At the beginning of January the Division was renamed the Occupational Psychology Research Unit. A senior industrial psychologist was obtained from England to take charge of this unit, and he commenced duty in mid-March.

PLANT CHEMISTRY LABORATORY

Director: Dr. J. Melville

THE NITROGEN CYCLE

The trials conducted by the Grasslands Division on the effect of clovers in the sward have yielded interesting information regarding the nitrogen cycle in pastures. Nitrogen is supplied by clover to the associated grasses by both underground and overground routes. Quantitatively the former is of less importance than the latter, and no clear-cut evidence is available as to the mechanism whereby underground transport of nitrogen takes place. Overground transport is effected almost solely through the grazing animal, and the amount of plant nutrients returned in dung and urine to a high-production sward is many times greater than the amount applied as artificial fertilizer.

Of the nitrogen voided by the sheep, about 75 per cent. is excreted in the urine, while 75 per cent. of the urinary nitrogen consists of urea. Studies have been made of the fate of this urea when applied to soil, and the following are the important points:—

(1) The rate of breakdown of urea to ammonia in soil is markedly affected by temperature, only 2 per cent. being hydrolysed in twenty-four hours at 41°F. and up to 35 per cent. at 77°F.
(2) Urea applied as urine is broken down much more rapidly than are pure urea solutions.
(3) The rapid production of ammonia in urine patches in summer markedly raises the pH of the top layer of soil, the highest value recorded in the field being well over 8.
(4) This may lead to serious losses of ammonia to the atmosphere, and such losses have been shown to occur to the extent of over 20 per cent. when solid urea is used as top-dressing.
(5) The conversion of ammonia to nitrate lowers the alkalinity of the top soil layers in a urine patch, although the effect lasts for some weeks. This conversion is stimulated by other urinary constituents.
(6) Urea is readily leached from the soil and may be lost to drainage water during periods of high rainfall.

Urine is the primary agent in producing grass-dominant pasture swards, and further work on the fate of urinary substances when voided on the sward is required. Corresponding work with fæces, which contain all the lime and phosphate excreted by the animal, is equally desirable.

NITROGEN METABOLISM IN PLANTS

These studies have their counterpart in the investigations of nitrogen metabolism of pasture plants which have been pursued for a number of years. Urea is taken up very rapidly by rye-grass roots, and urea concentration in the leaf rises markedly within a few hours after urea application to the soil. This is also probably true to a lesser degree of other urinary constituents, and indicates that the accepted nitrogen cycle in soil—where all organic nitrogen must be changed at least as far as ammonia, and ultimately to nitrate, before being utilized by the plant—requires revision under pasture conditions.

Work on the urea metabolism of green leaves is being vigorously pursued, primarily with the object of determining whether the urea-urease system acts merely as an internal source of ammonia or whether urea can be used by the leaf as a raw material for synthesis. Simultaneously investigations are being made of the free amino acids of green leaves, the amino-N fraction being quantitatively the most important of the major

groups in the soluble nitrogen fraction. Microbiological methods, partition chromatography, bacterial decarboxylases, and electrodialysis are all being used for the separation and estimation of individual amino acids. The key amino acids are aspartic and glutamic acids, which with their amides, asparagine and glutamine, represent more than half the total amino acid content of the soluble fraction. The basic amino acids are present in only small quantities, and it is obvious that the green-leaf proteins possess a quite different amino acid structure from that of the soluble fraction.

A limited programme of work on the rye-grass akaloids has been undertaken during the year in order to work out better methods for large-scale extraction and purification. The preparation of relatively large quantities is necessary for the determination of the chemical structure of the alkaloid, and when that is completed it will be possible to investigate its precursors and degradation products in rye-grass leaves.

SEED RESEARCH

The use of various stains to determine viability in dormant or slow-germinating seeds acquired considerable importance during the war. The technique has been applied to Chewing's fescue seed, with the result that germination can be determined in forty-eight hours instead of twenty-one days as in the standard test. The studies are being extended to other small seeds of economic importance, and are expected to be of considerable benefit in the treatment of seed of high moisture content.

A long-term study has been begun of the development, maturation, and ripening of seeds of perennial rye-grass and white clover, with special reference to changes in moisture content, increase in dry weight, and stage at which the seed acquires its germinating-capacity. The investigation, which must extend over several harvests, will provide basic information of the type which has proved so valuable with the cereal grains. Correlated with this work is the determination of influence of temperature on the equilibrium moisture content of small seeds and relative humidity of the atmosphere. No real advance in the problems associated with harvesting, storage, and retention of viability of small seeds can be made until this fundamental information has been assembled.

The viability tests on which all this work is based is being done under conditions most favourable for germination, conditions which bear little relation to germination in the field. Studies are in progress to determine the physical conditions, particularly acidity and salt concentration, which are necessary for germination and establishment.

HORMONE-TYPE WEEDKILLERS

Two methods for the estimation of minute quantities of 2, 4-D have been worked out, a biological one making use of the inhibition of seed-germination and a physico-chemical one using the ultra-violet absorption spectrum. They are useful both in field studies and in determining the amount of weedkiller absorbed in the tubing of spray equipment.

MICROBIOLOGY

The fermentation tank and ancillary equipment were installed by June, 1948, and a number of successful fermentations, using *Penicillium chrysogenum*, have been carried out. As was expected from the experience of overseas workers, a host of teething troubles have been encountered, but these have been overcome. The Laboratory has now a versatile pilot scale fermentation plant which can be utilized for practically any type of industrial fermentation.

Some 450 specimens of the endemic species of *Polyporaceae* and of fungi on native woods have been collected, of which 324 are maintained in culture. Tests for antagonistic properties have been carried out on 288, but only 15 cultures give reasonably good inhibition zones.

A similar study is being made of *Actinomycetes* isolated from soil samples of widely varying origin and supplied by the Soil Bureau and the Soil Fertility Research Station. Of the 120 cultures thus obtained, about half have been tested and 36 show antagonistic properties. Some of the strongly antagonistic cultures are being grown in submerged culture to determine the most suitable medium for antibiotic production. The opportunity is being taken also to attempt some work on the systematics of this rather confused group of micro-organisms.

At the request of the Medical Research Council, a survey is being made of the atmospheric spore load throughout New Zealand. Plate exposures at twenty-five selected localities give an approximate but useful measure of the numbers and types of moulds in the atmosphere. The most common types are isolated and grown in mass cultures for the production of dry spores for skin tests. A number of positive reactions for allergens have been reported from these spore preparations.

MINERALS IN PASTURE

The carefully conducted trials by the Grasslands Division on the effect of clovers on the sward, with and without the addition of lime and phosphate, have been used in a detailed study of the mineral constituents of the separate components of the sward. The most important results from the first two-and-a-half-years are:—

(1) Protein content of the grass component is highest during the winter months (up to 33 per cent.), with a minimum for the high-producing swards during the summer of 20 per cent. Clovers with a maximum protein content of 35 per cent. show less seasonal variation.

(2) The lime content of both clovers and grasses show seasonal variations, the average content of the former being about twice as great as of the latter.

(3) The phosphate content of the grasses is always slightly higher than that of the associated clovers, and it is estimated that, on an average high-production sward, phosphate uptake by grasses represents between 75 per cent. and 80 per cent. of the phosphate removal from the soil.

FORAGE CROPS

The branch laboratory at the Agronomy Division, Lincoln, has been established and equipped, and a start has been made on the biochemical problems connected with the breeding and utilization of forage crops.

PLANT DISEASES DIVISION

Director: Dr. G. H. Cunningham

PLANT DISEASES INVESTIGATIONS

Tomato Spotted-wilt.—The natural host range has been extended to include buttercup, wild radish, cape gooseberry, *Primula malacoides*, *Schizanthus*, and *Viscaria*. A number of strains of the virus have been separated, but further purification is necessary before their exact number can be determined. Under natural conditions, strains always occur as complexes.

Cucumber-mosaic.—The natural host range has been extended to include celery and *Delphinium*. Two of seven lines of cucumbers introduced from the United States of America showed resistance under test conditions.

Tobacco-mosaic and Tomato-streak.—The natural host range of tomato-streak has been extended to include cape gooseberry.

Both viruses are transmitted with uncleaned seed, whereas trials have shown that they are not carried with seed cleaned by fermentation or acid treatment. Extraction by fermentation allows the seed to be thoroughly washed and removes a considerable amount of the virus. Acid treatment not only allows thorough washing, but the low pH actually destroys the viruses.

Tomato Aucuba-mosaic.—This strain of tobacco-mosaic has now been found in New Zealand. It developed to the extent of 100 per cent in two glasshouses in Auckland during the past season. Losses are much heavier than with the type strain.

Beet-mosaic.—This virus, which until recently had been confined to the Manawatu, has appeared in Canterbury. Its natural host range has been extended to include silver beet.

Lettuce-mosaic.—The natural host range has been extended to include groundsel. Vectors have been determined as *Myzus persicae*, *Macrosiphum solanifolii*, and *Aphis gossypii*, the last being a new record. The virus is non-persistent in its vectors. Physical properties of the virus are similar to those of Lactuca virus of Smith (1937). Yields are greatly reduced when plants are infected early in the season. Artificial transmission of the virus has been made to pea, sweet pea, endive, aster, cineraria, and marigold, the last four being new host records.

Strawberry-crinkle.—This virus has been found to be widespread in the Dominion.

June-yellows.—A severe yellow and green mottling of foliage of the Captain Cook variety of strawberry, present in Auckland and Waikato districts, has been shown to be caused by the same disease as that producing June-yellows in the United States of America. It is not graft transmissible.

Hop-mosaic. Preliminary investigations with a bold yellow mottling of hop leaves, from a garden in Sherry River district of Nelson, have shown the condition to be transmissible by inarch grafting. Similar symptoms have been observed on hops from Tasmania being grown at Levin.

Plum-mosaic.—The disease has been found to occur naturally on apricots and Japanese and English plums. It is transmitted by budding.

Apple-mosaic.—The disease is now known to be widespread throughout the Dominion. The natural host range has been extended to several varieties of crab apples. It has also been transmitted experimentally to hawthorn and loquat.

Tomato Leaf-mould.—A further tomato variety, Improved Bay State, imported from the United States of America, has been tested for resistance to this fungus. Ten per cent. of plants showed a high degree of resistance, the others less. A check species, *Lycopersicum peruvianum*, showed a resistance of 100 per cent. Yields of this new variety were compared with the commercial Potentate with promising results, Improved Bay State producing an average per plant of 7lb. 13oz., as against 5lb. 10oz. for Porentate.

Verticillium-wilt.—The only species of fungus isolated from plants showing typical wilt symptoms was *V. dahliae*. It has been found attacking stock, aster, fat-hen, and black nightshade. A survey of field and glasshouse tomato crops was made during the season in two districts. At Auckland an average of 21 per cent. infected plants was found in 15 glasshouse crops, and 44 per cent. in the field. At Christchurch an average of 12 per cent. infected plants was found in 14 glasshouse crops, and 20 per cent. in two field crops. Twenty-one tomato varieties were tested for resistance to the disease, all proving susceptible.

Fusarium-wilt of Watermelons.—Five watermelon varieties imported from the United States of America were tested for resistance to the causal organism, *Fusarium bulbigenum* var. *niveum*. The following percentages of surviving plants were secured: Hawkesbury, 88 per cent.; Klondyke R7, 57·1 per cent.; Blue Ribbon, 30·4 per cent.; Klondyke black-seeded, 14·8 per cent.; Klondyke brown-seeded, 15·3 per cent.

Red-core Root-rot of Strawberry.—The disease, caused by *Phytophthora fragariae*, is prevalent in Auckland Province, and has also been isolated from infected plants from Wellington and Canterbury. Of 15 nurseries examined, 8 were found to be infected. Severity of infection was highest in soils with a high moisture content.

Yellow-leaf of Phormium tenax.—A comprehensive investigation is being resumed on this, the most serious disease of our indigenous fibre plant. Surveys are being made of phormium areas and possible pathogens isolated.

Blind-seed of Rye-grass. Because of climatic conditions during flowering, the disease did not develop in plots in a quantity sufficient to allow of conclusive results being secured.

Pea Diseases.—A comprehensive survey was made to ascertain those pea diseases present in commercial areas of Auckland and Canterbury. Of 76 crops inspected, 51 were grown in Canterbury and 25 in Auckland. The most widespread and serious disease noted was collar-rot, caused by the three fungi, *Ascochyta pisi*, *A. pinodella*, and *Mycosphaerella pinodes*, 11 crops being attacked severely, 6 moderately, and 46 slightly. Downy-mildew (*Peronospora viciae*), though widespread, caused little injury: of 42 crops found infected, 1 was severely infected, 3 moderately infected, and 38 slightly infected. Wilt (*Fusarium* sp.) was not widespread: of 16 crops found infected, 6 were severely attacked, 1 moderately so, and 9 slightly. Fusarium foot-rot (*F. solani* var. *martii*) was found in 5 crops, 1 being severely attacked. Other diseases noted, but causing little injury, were septoria-blotch, sclerotinia-rot, grey-mould, powdery-mildew, and pea-mosaic.

Linum-rust (Melampsora lini).—Sixteen varieties of linseed and 7 of linen flax were tested for resistance to this rust with material collected from Canterbury and Southland. Of the linseed varieties, Shevenne and B5128 (ex North Dakota Experiment Station) were highly resistant, Golden Viking moderately so, and the others moderately to highly susceptible. The linen flax variety, Liral Crown, was susceptible, but others tested—Wada, Cascade, Argentine II, and three Russian selections (Strakhanovetz, D. 83, and 806/3)—were highly resistant.

During this work single plant selections were made of rust-immune plants appearing among several susceptible varieties grown to maturity, and seed harvested for future investigations.

Linum-rust Races.—Investigations are proceeding in identification of races of the rust present in New Zealand. Two have so far been isolated.

Linseed Crop Diseases Survey. Some 95 crops in Canterbury, Otago, and Southland were examined. Browning (*Polyspora lini*) was found in 14 crops, 5 being severely infected, the disease appearing mainly in Southland crops. Pasmo (*Sphaerella linorum*) was found in 21 crops, 3 being severely infected, mainly of the variety Golden Viking. Wilt (*Fusarium lini*) was found in one crop of the variety Punjab, in North Canterbury.

Fireblight (Bacillus amylovorus). The organism has been found to remain viable in apple-fruit spurs, following blossom infection, until bud-movement of the following season, suggesting that control by use of copper sprays may prove effectual. Work on this phase is in progress.

Stem-blight of Pea.—Though uncommon, this disease is becoming more prevalent in the districts of Blenheim and Nelson. Tests for resistance under glasshouse and field conditions have been made with 11 varieties of field and garden varieties, the least susceptible (Greencrop) showing 53 per cent. infection.

Crown-gall (Bacterium tumefaciens). Control measures have been attempted by modifications of soil pH and chemical treatment of plants in field and glasshouse. Artificially injured plants produced galls, irrespective of soil reaction. Uninjured transplants formed very few galls in any soil reaction.

Treatment of plants by painting, injection, and application in paste of certain antibiotics, chemicals such as colchicine, acenaphthene, and dioxane, and such bactericides as elegtol, iodine, clove-oil, and mercuric chloride were carried out (*a*) when the organism was injected and (*b*) after galls had formed. Antibiotics (penicillin, streptothricin, and actinomycin) did not prevent gall-formation or retard formed galls. The chromosome-splitting chemical, colchicine, both prevented gall-formation and induced breakdown of formed galls. It has not, so far, killed organisms injected. Dioxane alone was effective in preventing galls, but did not significantly reduce size of formed galls.

THERAPEUTANT TESTING

Improvements in Disease Control

Grape Mealy-bug.—A spray of 1 per cent. p.p.i. D.D.T. applied just before buds burst in spring, followed by a 5 per cent. dust of D.D.T. at thinning, gave best results of any tested. Chemical analyses have shown that residues are well below the permitted maximum. Unfortunately, use of D.D.T. often results in increased infestation by red spider.

Red Mite and Clover-mite of Apples.—Selocide (a selenium-containing spray) for control of mites has been further investigated. One or two sprays applied at blossom period gave commercial control when used at 1½ pints per 100 gallons.

Leaf-roller Caterpillar. Successful control has been secured by use of Rothane (dichlor-diphenyl-dichlorethane).

Woolly-aphis.—Encouraging results in control of this pest have been secured with applications of benzene hexachloride during the dormant season.

Brown-rot of Peaches.—Work with Phygon (dichloro-naphthoquinone) has been continued, following previous work in which it was established that this product gave a higher degree of control than any other product.

Tomato Late-blight.—Several new products have been tested for control of late-blight, but none proved superior to the copper products in commercial use.

Certification of Therapeutants

Forty-seven products were certified during the year. In sample checks all products certified proved to be of satisfactory quality. Derris sprays and dusts have been withdrawn from certification owing to the superior control given by D.D.T. products.

TIMBER PRESERVATION INVESTIGATIONS

The section moved into a new building on the Owairaka area early in the year. Some time was consequently spent in dismantling equipment and re-establishing it in the new building.

For report of investigations see under "Reports of Research Committees of the Council of Scientific and Industrial Research—Building Research."

MISCELLANEOUS

Legume Culture.—Culture for 319,000 lb. of lucerne seed has been supplied to 2,528 farmers. This is an increase of approximately 105,000 lb. over the previous highest figure (1946–47), and represents a 50 per cent. increase in quantity.

Testing Household Insecticides. Tests in a Peet-Grady apparatus have been continued during the year with the housefly, *Musca domestica*. Pyrethrum and Thanite have been evaluated, and work is being carried out with Lethane 384 Special. Because of variation in resistance of the laboratory-bred strain, it was found necessary to commence a fresh culture of houseflies in November.

Poor results were secured in fly control with showcards (suitable for food-shops) painted with poster paints containing D.D.T.

Investigations are being carried out—following numerous complaints regarding inefficacy of D.D.T. to control flies—to ascertain if D.D.T. resistant strains are present, or are being developed, in the Dominion.

Fabric-pest Project.—With the purpose of working out adequate methods for proofing fabrics (carpets, woollens, &c.) against insect attack, a temperature and humidity control apparatus has been installed and checked. Stocks of various species of fabric pests have been established for test purposes, and their life histories are being investigated. Various methods of testing moth-proofing agents are being tested so that standard test methods may be established.

Overseas Visits.—During the year the Director and Senior Entomologist made visits overseas. The former attended the Fourth Commonwealth Mycological Conference and spent some months visiting various research centres in Great Britain. The Senior Entomologist attended the Fifth Commonwealth Entomological Conference in London, the International Entomological Conference held at Stockholm, and visited various research centres in Great Britain, Holland, and Denmark. He returned via South Africa, where possibilities were investigated of bringing to New Zealand shipments of sweet oranges without the risk of introducing Mediterranean fruit-fly.

Publications.—Twenty-nine technical papers were prepared by the staff and submitted for publication. A revised "List of Plant Diseases in New Zealand," last published in 1939, is being prepared. A comprehensive bulletin covering tomato diseases and pests is in the hands of the printer.

SEISMOLOGICAL OBSERVATORY

Director: Mr. R. C. Hayes

SEISMOLOGY

Summary of Seismic Activity in New Zealand in 1948.—Most of the principal earthquakes in 1948 were in the South Island. The largest disturbance occurred on 23rd May in the Hanmer-Waiau region, when intensity M–M VIII was reached in the strongest shock. Some buildings in the epicentral region suffered structural damage, and minor activity continued at intervals for some months. Other strong shocks occurred on 15th January off the Manawatu coast, on 19th June off the west coast of the South Island, and in July in the Monowai region; the first two of these were widely felt. There was some concentration of minor activity in the Taupo region early in the year, and occasionally in the Wanganui region also. On 26th January a slight shock was felt at some places around the Kaipara Harbour. There were 127 earthquakes reported felt during the year, 81 being felt in the North Island, 53 in the South Island, and 7 in both Islands. The maximum intensities reported were M–M VI in the North Island and M–M VIII in the South Island.

Seismograph Stations.—All seismograph stations were operating continuously, but the teleseismic instruments at Christchurch were out of action early in the year owing to reconstruction of the recording apparatus. Mr. L. G. Penfold, an amateur seismologist in Dunedin, made available some of his records, which were of considerable assistance in the location of some of the South Island epicentres.

The Wenner seismograph was fitted with a new triggering mechanism by the Dominion Physical Laboratory. The starting pendulum is now operated by comparatively small earthquakes.

The Dominion Physical Laboratory constructed a set of Wood-Anderson seismographs for the establishment of four additional stations. It is hoped to have these instruments installed early in 1949.

Seismograph Timing.—Some tests were carried out by the Dominion Physical Laboratory with apparatus designed for the automatic recording of radio time signals at seismograph stations.

TIME SERVICE

Time Signals Sent Out.—The usual time service was maintained without interruption, and the accuracy in time keeping was considerably higher than in previous years. The error of the ZLW time signals was on most occasions less than 0·1 second; the maximum error was 0·22 second. Transmission of the signals failed completely on three occasions and partially on one occasion; all failures were due to causes outside the Observatory.

From 1st April special signals were sent out daily, through ZLW, from 6 p.m. to midnight in connection with longitude determinations being carried out by the Lands and Survey Department's Geodetic Survey. The errors of these signals were supplied to the Surveyor-General every week.

Public Clocks.—The Government Buildings' clock was checked daily at 9 a.m., and regulated when necessary. The maximum errors observed during the year were 26 seconds fast and 46 seconds slow. The clock is regulated by officers at the Government Buildings as directed by the Observatory.

The synchronous electric clock ran continuously, except for three stoppages due to power failures in June and July. The maximum errors observed during the year were 23 seconds fast and 17 seconds slow.

Time Service for Carter Observatory.—Advice was given to the Carter Observatory Board regarding a proposed arrangement for supplying the Carter Observatory with accurate time for astronomical work.

WORKSHOP

A small workshop was established during the year for carrying out instrument-making, servicing and repair work for this Observatory, and also for the Meteorological Office and Carter Observatory. The workshop is staffed by an instrument-maker seconded from the Dominion Physical Laboratory. Repairs that cannot be carried out in the Observatory workshop are attended to by the Dominion Physical Laboratory.

SOIL BUREAU

Director: Dr. L. I. Grange

EROSION SURVEYS

A bulletin describing soil erosion in the southern half of the North Island was published.

SOIL SURVEYS

General Survey.—The four-mile-to-an-inch soil maps of the North Island have now all been published. The mapping of the South Island has been completed with the exception of Marlborough Sounds, Karamea district, and Stewart Island.

District Surveys.—Officers of the Canterbury Agricultural College have collected most of the agricultural information required for the bulletin dealing with the soils of Ellesmere County. Agricultural notes for Hutt and Makara Counties and Matakaoa County are being compiled by officers of the Department of Agriculture to complete data for bulletins on these counties.

Detailed Surveys.—About 320 square miles, containing much undeveloped land, have been mapped in the Taupo district. A survey of the alluvial flats of Gisborne has been started. In the mapping of soils on the Wairarapa Plains, 450 square miles have been completed.

Besides the above, several detailed surveys of small areas have been made at the request of various organizations—*e.g.*, the Canterbury Agricultural College farm, as a basis for field trials, &c.: Omahutu and Waitangi State Forests in relation to *Pinus radiata* growth: and airports at Auckland, Rotorua, and Invercargill.

SOIL CHEMISTRY

Salt in Coastal Soils.—It has been found that salt spray in coastal areas is largely responsible for producing clay-pan soils. Analyses of rain-water in these areas show that as much as 3 cwt. of common salt per acre is added each year to the soil.

Effect of Dung and Urine Return on Soil Fertility.—Analyses of soils at Lincoln, comparing plots with dung and urine return against no return but with artificial fertilizers added, indicated only one significant difference—a great increase in exchangeable potash in the dung and urine plots.

Composts.—Analyses for municipal bodies have been made of composts and advice given that has helped in securing a useful product.

Soil Phosphates.—Other workers have shown experimentally that phosphate "labelled" with radioactive phosphorus added to a soil loses a part of the radioactive element to some native soil phosphate. Experiments are in progress in the Soil Bureau aimed at reducing this interaction to a minimum and estimating its extent.

Soil Corrosion.—Tests on the soils surrounding steel plates buried for twelve years correlated 75 per cent. with the actual corrosion obtained. A number of tests have been prepared for firms and local authorities on corrosion hazards of proposed pipe-lines.

Soil Biochemistry.—Peach-trees showing manganese deficiency due to overliming have been top-dressed with sulphur. Dressings of 2 lb. to 4 lb. per tree have in fifteen weeks increased acidity to an extent suitable for tree growth (pH 7·5 to pH 6·5 in the top 8 in. of the soil).

SOIL PHYSICS

Soil Mechanics

Earth Dams.—Testing of foundations and embankment soils for proposed earth dams were carried out at Whakamaru (Upper Waikato River), Lake Pukaki, Roxburgh Gorge, and Lake Wanaka. Points of interest are that at Whakamaru the soil to be used for the dam had excessive moisture as it occurs *in situ*. The foundation soil of the Lake Wanaka proposed dam is a silt of narrow particle size which has too high a water content for satisfactory stability. The possibility of improving its properties by electrical or vacuum drainage is being investigated.

Foundation Surveys.—Foundation surveys were made for a phosphate-rock store at Westfield, Auckland, for extensions to the new hospital at New Plymouth, and on an existing porcelain-firing kiln where settlement was due to soil shrinkage.

Agricultural Soil Physics

Physical measurements were made of Canterbury wheat soils under continuous cropping in comparison with those soils under normal rotation. The only significant difference found was that the former contained less aggregates.

SOIL BIOTICS

Biological Assay

A map has been prepared showing the copper content of North Auckland soils as determined by the Aspergillus method. In the survey of the Pinaki suite copper is low throughout, whereas in the heavier soils of the Omu suite copper is satisfactory in the immature stage and low in the strongly leached (gum land) stages. The brown loams and brown granular clays derived from volcanic rocks have a high copper content in the young and immature stages, but are on the low side in the most leached (ironstone) stages.

The Omu suite of soils of North Auckland were tested in pots with indicator plants, and all were shown to be deficient in boron. The least leached of the soils required 20 lb., and the most required 30 lb., to rectify it.

Soils of Motutapu Island gave a response to phosphate, but unhealthy growth appeared later and was remedied by the addition of a nitrogenous manure.

A trial of compost in pots demonstrated that the compost gave a response equal to its available nitrogen content.

A survey is being made of the worm population of North Auckland soils. Several new species of native worms have been found in virgin soils; the two common species in cultivated soils have been introduced from Europe. A greater density of population of earthworms was found in soils carrying good pasture than those with poor pastures, and this was independent of soil type.

REPORTS OF RESEARCH COMMITTEES OF THE COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

BUILDING RESEARCH

Research investigations relating to building problems have been carried out by officers of the Dominion Laboratory, the Dominion Physical Laboratory, and the Plant Diseases Division. Consideration has been given to the problem of testing the fire resistance of materials and structures. This work has been undertaken following the report of the Royal Commission on the fire of Messrs. J. Ballantyne's premises, Christchurch, and at the request of the Standards Institute. No agreement has yet been obtained regarding the appointment of a Director of Building Research and the establishment of an organization along the lines recommended by Sir Reginald Stradling. It is hoped to make an appointment in the ensuing year. Such an appointment is essential in order that a more positive approach can be made to the problems which are arising.

DOMINION LABORATORY

This work included the analysis of 246 samples of paint for compliance with specifications, an extensive series of outdoor exposures of paints on test fences in widely separated parts of the country, laboratory accelerated weathering tests of paints, an extensive investigation of the incidence of and causes for the failure of paint on some houses, and many other investigations related to paint. Assistance in the preparation of a new standard specification for ready-mixed paints for outside use was given to the New Zealand Standards Institute. Much work was done on improved methods of analysis of paint pigments.

Concrete roofing-tiles were examined for Government Departments and for tile-manufacturers with respect to mechanical strength, water absorption, and grading of the aggregate. A report was prepared on the colouring of concrete tiles.

In conjunction with the Chemical Engineering Section, an investigation was carried out into the methods of manufacture of clay roofing-tiles. As a result, recommendations were made which provided improved methods of manufacture and reduction in production losses.

Investigations have been carried out on the use of concrete in dams. These have included analyses of concrete taken from dams which showed signs of deterioration and the testing of lake waters in the South Island to determine what effect they would have on concrete dams and steel structures.

The Minerals Section started investigation of an American test that may enable predictions to be made of the behaviour of rocks used as aggregates in concrete. Possible pozzolanic materials for use in concrete were investigated by the conductivity method of Lea.

In connection with corrosion problems, the amount of carbon dioxide in natural waters was investigated. The results will be made available in an information circular.

Two members of the staff gave scientific evidence before the Royal Commission inquiring into the fire at Messrs. J. Ballantyne's premises.

The *Paint Review* was published at two-monthly intervals. It serves to keep practical painters informed of scientific advances in paint materials and methods.

DOMINION PHYSICAL LABORATORY

Physical Properties of Pinus radiata. A quantity of *Pinus radiata* of three different structural sizes selected and graded in the normal manner was supplied from the State Forest Mill, Rotorua. The timber was stacked for normal air drying, and will shortly be ready for test. The data obtained will be referred to the New Zealand Standards Institute for incorporation in a building code.

Rock from Cobb River, Roxburgh, and Atiamuri Hydro Sites.—Various mechanical properties of foundation rock from the above dam-sites have been measured for the Ministry of Works.

Concrete.—Steps have been taken to set up a laboratory for investigating the mechanical properties of concrete and concrete products. The problem of immediate interest is that of air-entraining agents and other proprietary admixtures for concrete, particularly for large structures. Long-term investigations into the durability of concrete made with local aggregates from various parts of New Zealand will also be undertaken.

Moisture Content of Timber in situ.—Progress is being made in determining the minimum rate of air change necessary in the stud space of houses, especially brick veneer houses, with a view to avoiding on the one hand the risk of dry rot, and on the other the probability of excessive cooling of the house interior.

Thermal Insulation of Walls.—A very considerable amount of information has been assembled during the year on heat losses through walls of various types of domestic dwellings *in situ*, as well as from experiments made under controlled conditions in the Laboratory. The results emphasize the importance of improving the insulation in many types of modern wall constructions.

Thermal Insulation of Pumice Shingle.—The use of pumice shingle as a thermal insulating-material, especially in such large scale projects as freezing-works, demands a knowledge of suitable sources of supply of the material and of its insulating properties.

Ventilation of Domestic Houses.—Further work on the natural ventilation of house rooms has been done in a cottage in which special ventilation arrangements have been installed. Ventilation and thermal insulation are the key factors in the control of mould growth on the inner surfaces of domestic dwellings, a problem which is now well understood from the work undertaken.

PLANT DISEASES DIVISION

Toxicity of Wood Preservatives

Biological Evaluation Against Insects.—This season tests were set up to ascertain effects with different timbers on toxicity towards *Anobium*, some 30,000 beetles being used. In collaboration with the Division of Economic Entomology of the Australian Council for Scientific and Industrial Research, Canberra, a method is being developed to measure toxicity of some water-soluble materials to subterranean termites. Test blocks prepared in the laboratory were sent to Canberra for exposure to infestation.

Biological Evaluation Against Fungi.—A test against four fungi was made with the Leutritz soil/block contact method, to test the toxicity of zinc chloride, Tanalith, sodium fluoride, and boric acid.

Field Tests.—Four materials—zinc chloride, Tanalith, sodium fluoride, and boric acid—were used to pressure treat timber employed in construction of a building at Oratia. Loadings were based on results of previous toxicity tests. Attempts will be made annually to infest the building with *Anobium*.

Treatment of Infested Buildings

Test treatments showed that different petroleum solvents possess different toxicities towards *Anobium*. Tests have now been extended to include several other insecticides.

Mass Breeding of Insects

Breeding of sufficient *Anobium* beetles for toxicity tests is being continued. In addition, supplies of *Lyctus* are being bred. Work has been commenced on breeding of *Ambeodontus*, mainly in the direction of ascertaining conditions required by this beetle for egg-laying.

Preservation of Pit Props

An investigation of diffusion treatment of mine props has been made, preparatory to treating a quantity to be installed in a coal-mine, with a view to testing the effectiveness of some water-soluble products as preservatives.

Preservative Treatment by Pressure

Investigations are being carried out on effects of different initial pressures and temperatures on absorption of aqueous solutions into tawa.

Preservative Treatment by Diffusion

Several preliminary diffusion treatments were made, and the information secured has been used in planning a trial to ascertain influence of a number of factors on treatment of tawa.

Leaching of Water-soluble Preservatives

Over 200 lengths of timber, treated with three water-soluble materials, have been exposed to weathering for periods up to six months. Losses of chemicals and changes in distribution are being measured periodically.

HOP RESEARCH

Director: Mr. A. S. Nash

On the recommendation of the Hop Research Committee, an appointment to the post of Director of the Hop Research Station was made at the beginning of the year. The Director was sent to England to study hop-growing in that country, and he investigated cultural methods, varietal and breeding work, disease and insect control, harvesting, drying, and grading. He also paid a short visit to Czechoslovakia, where hops have been grown for over one thousand years. A member of the Chemical Engineering Section of the Dominion Laboratory paid a short visit to Tasmania to study the hop-drying methods practised there. Great difficulty has been experienced in obtaining a suitable area of land for a research station, but recent negotiations appear to hold out some hope that this difficulty will soon be overcome and that a more adequate research programme can be commenced this coming spring. The research programme, yet in its infancy, is being carried out partly by the Department, and partly by the Cawthron Institute with the aid of a special grant from the Department.

DEPARTMENTAL INVESTIGATIONS

Disease-free cuttings of promising new varieties developed by the South-eastern Agricultural College, Wye, England, were brought back by the Director and have been planted in an isolation area at Havelock North. These varieties are characterized by high yielding-capacity, and from the brewing standpoint they have a high preservative value.

A preliminary aerial survey of hop-gardens was carried out in February and gave many valuable indications, which were followed up by examinations on the ground.

Preliminary experiments on hop-drying were carried out at the Dominion Laboratory, Wellington, by the Chemical Engineering Section, and useful basic data on the drying characteristics of hops have been obtained. Progress has been made in designing a suitable type of small experimental hop-drying unit that will give precise control of temperature, humidity, and air flow over a wide range.

CAWTHRON INSTITUTE INVESTIGATIONS

Disease Survey in Hop-gardens. Some twenty representative hop-gardens have been examined for the presence of disease. Ten gardens in Upper Moutere and Wai-iti appeared free from disease, but black root-rot (*Phytophthora* sp.) was identified in eight other gardens. Canker (*Gibberella* sp., *Fusarium* sp.) was found in several gardens, and leaf symptoms suggestive of virus disease—chiefly mosaic or nettlehead—were observed in eight widely scattered gardens. No case of wilt (*Verticillium albo-atrum*) was found during the survey.

The possible correlation of soil characteristics with disease incidence has been examined. Although hop plants invariably show some dead roots, the growth of plants is apparently not affected on well-drained sandy loams, or loams underlaid by gravels at a depth of 12 in. to 18 in. Gardens seriously affected with root disease were located on soils of heavier texture, with poorer drainage, or on sandy soils with a somewhat high water-table. There is little doubt that the increasing demand for light soils for flue-cured tobacco is restricting hop culture to the heavier, less well-drained soils.

Value of Chemical Disinfectants for the Treatment of Disease-infected Gardens.—Chloropicrin and D-D are being examined as possible chemicals for sterilizing infected soils so that diseased hillsides can safely be replanted with new sets. The therapeutic value of the materials cannot yet be assessed, but it was noted that chloropicrin caused some temporary retardation of hop growth early in the season. Supplementary small-scale tests in tins have also been made with naturally infected and artificially infected soils. Direct application of chemicals to hop cuttings before planting is also being tried.

Crown Disinfection of Hop Plants.—Information is being sought on the value of chemical disinfection of the crown of hop plants at the time the crown is exposed for pruning in the spring. Of seven materials tested, three have injured the plants.

Tasmanian Hop Cuttings.—Hop cuttings of the varieties Kent Golding, White Bine, and Lates were imported from Tasmania by the Committee, and were planted in isolation at the Dominion Horticultural Station at Levin.

On subsequent inspection a leaf mottling—suggestive of virus—has been found in Kent Golding, but not on White Bine or Lates, although these latter may be symptomless carriers of mosaic. Two types of symptom suggestive of other virus diseases have been noted in a few plants of White Bine and Kent Golding. In the circumstances, the plants cannot yet be safely introduced into the Nelson district.

MANUFACTURERS' RESEARCH COMMITTEE

Secretary-Executive Officer: Mr. R. T. Wright

The Committee has continued to give advice and active assistance in the application of scientific research by New Zealand's manufacturing industries, and close relations have been developed and maintained with the New Zealand Manufacturers' Federation and its district and trade associations.

Research Associations.—These co-operative associations, which are accorded a pound-for-pound subsidy by Government, have proved to be the most satisfactory method of ensuring industrial interest in scientific research, and the response of manufacturers to the development of these associations when incorporated has been most gratifying. The Committee has maintained a close contact with these associations, and during the year has sponsored the reorganization and incorporation of the New Zealand Leather and Shoe Research Association.

Industrial Research Fellowships.—Cabinet has approved in principle the inauguration of industrial research fellowships for those industrial groups that are either too small or have insufficient community of interest to warrant the establishment of research associations. A suitable scientist would be engaged to work in an approved laboratory on the special scientific problems of the sponsoring group, the Government contributing half the cost. Negotiations with a number of interested groups are in progress.

Servicing of Industry.—Assistance to industry in scientific and technological matters has been maintained by the Dominion Laboratory, the Dominion Physical Laboratory, the Auckland Industrial Development Laboratories, &c. Active assistance to the South Island manufacturers is being developed through the establishment of an Industrial Development Division at Canterbury University College, in the advisory and financial

control of which the Committee is represented. Industrial liaison officers have been appointed in Auckland, Christchurch, and Dunedin, and they have achieved good results in making industry aware of scientific developments and of the assistance available from the Department.

Many other activities of a wider general nature, in furtherance of its policy of ensuring the maximum scientific and technical service to industry of the resources of the Department, have engaged the attention of the Committee.

NEW ZEALAND RADIO RESEARCH COMMITTEE

During the year the Committee has continued its work of co-ordinating the radio research of State Departments, the University colleges, and the Carter Observatory. A number of projects sponsored by the Committee are in operation or are pending. These include the following investigations: reflections from the D region, at Canterbury University College; oblique incidence ionosphere studies, at the Dominion Physical Laboratory; short-wave directional propagation, at Seagrove Research Station; and a programme of auroral photography, at Carter Observatory.

The Radio Research Office of the Dominion Physical Laboratory has continued its correlation work, and a series of progress reports is now being issued.

Nine papers were presented, through the Committee, to the British Commonwealth Specialist Conference on Radio Research in London, and to the General Assembly of International Scientific Radio Union held in Stockholm during the year. The recommendations of these two gatherings and of the plenary assembly of the International Committee on Radio Communications (CCIR) have been put into effect in New Zealand.

(See also report of Dominion Physical Laboratory on p. 26.)

TOBACCO RESEARCH

Director: Mr. R. Thomson

The past season has not been entirely favourable for the growth of the tobacco crop. Rainfall for the spring months was below the average, and although this enabled the preparation of the land to be carried out early, it resulted in the soil being rather dry, with little or no reserve moisture. A showery November made for good planting conditions, but was followed by a dry spell. Considering the dry condition of the land the summer rainfall was insufficient. This was confirmed by the excellent growth of the irrigated crops. Temperatures during the season were not extreme, but some cool nights were recorded. The Station crop, along with others in the district, suffered from a severe hailstorm on 26th January: frosts late in March caused further loss of leaf and there was more wind than usual, particularly during the early summer.

Owing to the adverse effect of flooding, the crop from the 1947/48 season was light, 14,320 lb. of leaf being harvested from 11½ acres. The 1948-49 crop will also be light as the result of hail damage.

SOIL STERILIZATION

In addition to the Station requirements, 400 yards of soil for seedling beds were steam sterilized for growers. This is an increase on any previous season. Most of this soil was used in beds which were subsequently direct seeded, indicating that growers are becoming more alive to the advantages of this practice in the control of mosaic.

SEEDLING-BED TREATMENTS

In an experiment to test the efficacy of various chemical treatments of the seedling-bed soil for the control of weeds, none proved as satisfactory as steam, although chloropicrin and calcium cyanamide brought about some reduction in weed population. In a trial of fertilizers for the treatment of seedling beds, 1 lb. per square yard of standard mixture proved superior to ½ lb., or to ½ lb. with supplementary nitrogen.

FERTILIZER EXPERIMENTS

1947-48 Season. - These are the results following the general flooding of the Station when some experiments had to be abandoned and others had to be considered with some reserve. Where the quantity of fertilizer per acre was varied, results confirmed previous indications that at least 1,200 lb. per acre should be used on soils of the Station type. Although no "sand drown" has been in evidence on the Station, increased yield and better-quality leaf have justified the inclusion of some magnesium in the fertilizer. Under conditions of flooding, leguminous cover-crops did not produce the rank tobacco of previous seasons, indicating that considerable leaching of nitrogen took place. Under the seasonal conditions, increase in phosphate gave higher yields and earlier maturity of the tobacco. That considerable leaching occurred received confirmation from the results of the source-of-nitrogen experiment. For the first time the plots receiving a high proportion of nitrate of soda gave the lowest yield of all treatments.

In the liming experiment, those plots without lime outyielded those receiving a dressing of ground limestone in the early spring. Results obtained in the first year of an experiment with boron suggested some benefit from 5 lb. borax per acre, even on land where boron deficiency had not been evident previously in the crop.

1948–49 Season.—The results of these experiments will not be available until the grading of the leaf is completed, but some general trends are noticeable. Differences due to the variations in the rate of fertilizer applications were apparent, indicating that from 1,200 lb. to 1,400 lb. could be used with benefit. In general, plots receiving 4 per cent. nitrogen were better than those receiving 3 per cent. Differences in growth due to varying the phosphate were evident, the best plots being those receiving high phosphate together with high potash. The addition of magnesium to the fertilizer appeared to be beneficial. There was no noticeable difference between high and low calcium mixtures. Ten pounds of borax per acre for the second season in succession appeared to have a retarding effect on the early growth.

In the cover-crop experiment, legumes detrimentally affected the following tobacco crop which produced rank growth and which ripened very slowly and wilted down in the hot weather. Where wide and narrow rows were compared, the former appeared to encourage earlier ripening.

CHEMICAL COMPOSITION OF TOBACCO WITH DIFFERENT FERTILIZER TREATMENTS AND CULTURAL PRACTICES

In the 1946–47 season, variation in the rate of standard fertilizer from 800 lb. to 1,400 lb. per acre did not have any pronounced effect on the sugar content of tobacco-leaves. The nitrogen content, however, varied from 1·39 per cent with 800 lb. application to 1·76 per cent. with the 1,200 lb. treatment. In another experiment the nitrogen content of the tobacco leaf showed an increase from 1·26 per cent. with 2 per cent. nitrogen in the fertilizer to 1·55 per cent. with fertilizer of 5 per cent. nitrogen.

Where the percentage of potash in the fertilizer was varied from 4 per cent. to 12 per cent. little variation in the sugar and nitrogen contents resulted. The use of a low calcium fertilizer was associated with a high sugar content in the tobacco-leaf. Little effect on the nitrogen content of tobacco was noted with high and low calcium fertilizers.

Influence of Cover-crop and Cultural Practice on Chemical Composition.—In the 1948 harvest the use of different cover-crops for ploughing in, prior to planting with tobacco, caused some variation in the sugar content of the tobacco harvested from the different plots. The highest sugar content was obtained on the rye-grass plot, followed by ryecorn, then lupins, and finally oats and tares plots. The variations in sugar content were small, and do not appear to be sufficient to affect the quality of the leaf. It must be noted, however, that the lupin crop was a poor one.

In the 1946–47 spacing experiment the tobacco grown with a 4 ft. by 2 ft. spacing gave 1·74 per cent. nitrogen in leaf samples, while the 4 ft. by 21 in. spacing gave leaf with a content of 1·65 per cent. nitrogen.

Nutrient Intake Experiments. The intake of plant nutrients continues during the harvesting period not only by the plant as a whole, but by the ripening leaves. The intake of plant nutrients is affected greatly by weather conditions, but a proportion as high as one-third to one-half of the total season's intake may be associated with the harvesting period.

Influence of Season on Composition of Tobacco-leaf. Considerable differences occur in sugar and nitrogen contents of leaves harvested in any one season. In 1944 and 1947 the sugar content of harvested tobacco-leaves rose to a distinct maximum, and then fell towards the end of the season. Nitrogen content of the leaf was low when sugar content was high. In the 1945 season, however, sugar content was highest in the early part of the season and fell consistently as the season advanced. Nitrogen content in this season was low in the early part of the season and increased at later stages of harvesting. Climatic conditions would appear to offer the best explanation of these seasonal variations in sugar and nitrogen content of the tobacco.

DISEASE INVESTIGATIONS

This work has included inspection of tobacco seedlings grown by nurserymen at Nelson and Motueka; surveys of tobacco-seedling beds and tobacco fields for mosaic, verticillium wilt, black root-rot, and angular leaf-spot. In addition, experiments have been continued at the Tobacco Research Station and at the Cawthron Institute concerning the control of mosaic, black root-rot, verticillium wilt, and sclerotinia in tobacco-seedling beds and in field plots.

Mosaic Disease

During October and November the seedling beds of twenty-five tobacco-growers were inspected, and the beds were found unusually healthy. Apparently greater care is being exercised by growers in the selection of sites for their seedling beds, in the choice of soil, and in the general management of the beds. The survey showed that tobacco-growers were raising more tobacco plants by direct sowing of seed in the beds. At least eleven growers out of those visited had some of their beds sown direct with tobacco-seed. Mosaic was observed in only small amount, twenty-three out of twenty-five growers having apparently clean beds.

During January an inspection was made of the tobacco fields of twenty-five representative growers located in different parts of the tobacco-growing districts, and it revealed less mosaic infection than in previous years.

In six comparisons between plants grown from direct seeding in the beds and pricked-out plants, the average amount of initial mosaic was 10 per cent. in the former and over 30 per cent. in the latter.

An experiment was designed to test the value of different chemicals in the treatment of the soil prior to sowing the seed or the pricking-out of tobacco seedlings. Mosaic counts on field plots planted with tobacco plants grown under the different treatments showed only 3 per cent. initial mosaic with the standard treatment and 43 per cent. with pricked-out plants. Steam, chloropicrin, and calcium cyanamide plus urea gave similar results, the percentage of initial mosaic in the field plots varying only from 2·6 per cent. to 3·5 per cent. The use of different amounts of standard fertilizer and increased amounts of nitrogen in the manurial treatment of the seedling beds was not associated, under the conditions of the experiment, with any increase of initial mosaic in the field plots. A considerable amount of secondary mosaic infection occurred in all the field plots, the percentage of secondary infection being similar, irrespective of the different treatments originally applied in the seedling beds.

In a demonstration plot to show how mosaic is spread by handling, the results of previous seasons were confirmed. In the control plot the percentage of infection was 1·4, while in an adjacent plot where 1 per cent. of infected material was handled, the infection was 93 per cent.

Verticillium Wilt

A small area of heavily infected land was treated with chloropicrin at 4 c.c. per square foot. This gave complete control of the disease. On an adjacent area treated with D-D the amount of disease was greatly reduced but not eliminated. A number of lines, including some Nicotiana species, were grown on infected land to determine whether any possessed resistance to the disease. Two varieties, T. 448A and Ky. 34, while not immune, appeared to be relatively resistant.

Black Root-rot (Thielaviopsis)

A survey of tobacco seedling beds of growers in different parts of the Waimea County showed only light infection with black root-rot.

Resistance of Cover-crops to Black Root-rot.—Several varieties of lupins, oats, barley, ryecorn, clovers, and vetch were grown in soil infected with black root-rot, and at a certain stage of growth the roots of the plants were examined for black root-rot. Algerian and Garton oats, barley, white clover, and vetch showed no infection, while ryecorn and red clover had less than 1 per cent. infection.

Lupins, however, differed widely in their susceptibility to black root-rot. Sweet Blue and Sweet White lupins showed 34 per cent. and 29 per cent. infection respectively. Pink Bitter lupins, with 48 per cent. infection, proved the least resistant, and Sweet Yellow lupins, with 3 per cent. infection, the most resistant to the fungus. New Zealand Blue lupins gave a figure of 18 per cent. infection. In all cases, infection with black root-rot must be regarded as in the "slight" category, and did not affect the growth of the crops. At a later examination an increase in infection was noted with New Zealand Blue lupins (54 per cent.) and with Pink Bitter lupins (69 per cent.).

Resistance of Tobacco Varieties to Black Root-rot.—Several varieties of tobacco were tested under seedling-bed conditions for resistance to black root-rot. The variety, Delcrest, showed the greatest resistance to the fungus, some 49 per cent. of the plants giving only slight to no infection. Vesta (all strains), H. Sp. 215, H. Sp. 218, Special 400, and Special 402 all showed very general infection of roots with black root-rot.

Sources of Black Root-rot Infection.—In view of the identification of black root-rot fungus in soil used by tobacco-growers for top-dressing seedling beds, further examinations have been made of soil normally collected by transport companies. Two locations were found to be infected with black root-rot, and a warning was issued to growers concerning the use of soil from these locations in the preparation of seedling beds.

Collar-rot (Sclerotinia)

Experiments have been continued with a view to the control of collar-rot in tobacco-seedling beds. This year Fermate and Shirlan were tested on infected soil. Neither chemical gave a satisfactory control, although a considerable reduction in infection of the tobacco seedlings occurred. Fermate was the more effective of the two fungicides.

TESTS OF VARIETIES

Once again Harrison's Special 215 maintained its reputation of high yield combined with good quality. Special 400 also yielded well, but it produces a thinner type of leaf, and the plant laterals freely, which is a serious consideration when labour is limited. Three new Oxford varieties bred for disease resistance produced only moderate yields.

This is in keeping with the recommendation that they should be used only where disease is a limiting factor. A series of new varieties from Virginia was under trial for the first time, as was a new Canadian variety, Delerest. This variety possesses a fair degree of resistance to black root-rot.

PLANT-BREEDING AND SEED-PRODUCTION

Breeding for mosaic resistance, using the Ambalema variety, has been continued. While resistant lines have been obtained, they still fall short of the desirable flue-cured type of growth. In breeding for resistance to black root-rot the results are promising, some apparently resistant lines being indistinguishable from the commercial parent types.

The production of seed for the commercial crop was continued, the policy of distributing seed from once-tested single plant selections being maintained. Four varieties were grown, and a satisfactory reserve of seed is being held in addition to meeting current requirements.

FIRE-CURED TOBACCO

A further area of fire-cured tobacco was grown, but the hailstorm in January severely damaged the leaf. Manufacturing trials of the 1945-46 leaf indicated that, while the leaf was of fair quality, it was harsh in texture and strong in smoking quality when compared with similar grades of American leaf.

KILNS AND CURING

Work with the small experimental kiln was continued. Results to date indicate that, in addition to producing a more uniform leaf, this type of kiln may shorten the drying period, require less fuel, and minimize the fire risk. It was hoped to do some fundamental work on curing, but the experimental cabinets were not available in time.

TOBACCO PLOTS AT TAKAKA

Three pilot plots of tobacco were grown in the Takaka Valley. They were all on new land and, therefore, could not be expected to produce good-quality leaf this season.

SOIL SURVEY OF TOBACCO LAND

During the year the detailed soil survey of the Stanley Brook valley was completed and tobacco soil maps covering this locality were finalized. Tobacco soil maps for a small area in the Baton and Dove Rivers locality have been drawn. Copies of the tobacco soil maps of the Tapawera and Stanley Brook localities have been prepared.

A commencement has been made in the revision of the tobacco soil maps for publication. The alluvial soils have been separated into six broad groups based on the origin of the parent material from which they are derived. This grouping has been superimposed on the original classification into six grades based on textural and drainage qualities. The revised map for the Motueka and Riwaka district, showing both geological and texural groupings, has been finalized. In view of the marked differences in boron, magnesia, and lime content which are known to occur on soils of different geological origin, the revised maps should prove valuable in the conduct of investigational work and in the adjustment of manurial programmes to the requirements of the different soils.

Some 50,000 acres of alluvial soils in the Waimea County have now been covered by detailed soil surveys and classified for flue-cured-tobacco culture. A study of the data derived from the surveys shows that 7,475 acres fall into categories 1 and 2, which are considered good to very good for flue-cured tobacco; some 14,026 acres belong to categories 3 and 4, which are considered more or less satisfactory; and 28,843 acres are regarded as unsuitable for flue-cured tobacco.

A consideration of the total acreage falling into categories 1 to 4 and its present utilization for different crops suggests that there should be no great difficulty in securing an extention in the Waimea County of the flue-cured-tobacco industry to 6,000 acres yearly if prices remain satisfactory.

DISTRIBUTION OF TOBACCO IN THE 1948–49 SEASON

Although it has not been possible to revise the tobacco maps showing the exact distribution of the crop in the Waimea County, a study of the acreages applied for by growers and made available by the Tobacco Control Board shows some changes in comparison with the 1947–48 season and an increase in the 1948–49 season of 148 acres.

(See tobacco soil investigations under Cawthron Institute.)

WHEAT RESEARCH INSTITUTE

Chief Executive Officer: Dr. O. H. Frankel

WHEAT-BREEDING AND WHEATGROWING

As in recent years, the Institute operated on its own station at Lincoln—where it has fourteen acres under wheat plots—and on 5 acres of leased land in a high-fertility area at Tai Tapu, about six miles from Lincoln: there were 8,236 plots at Lincoln and 1,247 at Tai Tapu. At the branch station selections are made that are designed for the wheat areas with high fertility in Canterbury and North Otago. In these districts Dreadnought gives high yields, but gives difficulties in harvesting. All the more advanced breeding lines are tested at both stations.

The breeding material included the fifth generation of the cross Hilgendorf × Cross 7, from which it is hoped to select a wheat with the best characteristics of both parents viz., an all-round high-yielding wheat with highest baking quality. Some of the selections look promising: one had a protein content of 18·5 per cent., which probably is unprecedented in New Zealand.

A heavy attack of mildew (*Erisyphe graminis*) made extensive observations possible on the degree of infection on breeding lines and in the collection. Resistant types were found, and some of these have been crossed with our standard varieties. These studies will shortly be extended in co-operation with the Plant Diseases Division.

Six new lines, from a number of compound crosses, have shown promise in tests at Lincoln and Tai Tapu, and will be included in the regional trials of the Department of Agriculture.

In this year's Extension Division trials the lines 202,01, from the cross (Cross 7 × Dreadnought) × (Cross 7 × Lin Calel), and 192,01, from the cross (64,02 × Cross 7) × (Tainui × Cross 7), again showed good promise. The latter line was found to consist of a number of types, which have been separated and will now be tested individually.

Hilgendorf, the Institute's new wheat, was released during the past season. Seventeen crops were sown, totalling about 220 acres. Reports indicate that with few exceptions farmers were satisfied with the new variety, in spite of the fact that the extended spring drought was a severe handicap for this early-maturing wheat. The seed available for the sowing of 1949 is sufficient for an area of between 3,000 acres and 3,500 acres. To encourage extensive trials by farmers with this high-quality wheat, the Government and the Flour-millers' Society have agreed to a continuation of the premium of 1s. per bushel for the coming year, the millers and the Government each contributing one-half of the premium.

Another new wheat, WRI-Yielder, is not yet ready for general distribution. A nucleus area of 9 acres did not prove sufficiently pure for distribution, and a further reselection has been provided.

This is in keeping with the recommendation that they should be used only where disease is a limiting factor. A series of new varieties from Virginia was under trial for the first time, as was a new Canadian variety, Delcrest. This variety possesses a fair degree of resistance to black root-rot.

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During the year the detailed soil survey of the Stanley Brook valley was completed and tobacco soil maps covering this locality were finalized. Tobacco soil maps for a small area in the Baton and Dove Rivers locality have been drawn. Copies of the tobacco soil maps of the Tapawera and Stanley Brook localities have been prepared.

A commencement has been made in the revision of the tobacco soil maps for publication. The alluvial soils have been separated into six broad groups based on the origin of the parent material from which they are derived. This grouping has been superimposed on the original classification into six grades based on textural and drainage qualities. The revised map for the Motueka and Riwaka district, showing both geological and texural groupings, has been finalized. In view of the marked differences in boron, magnesia, and lime content which are known to occur on soils of different geological origin, the revised maps should prove valuable in the conduct of investigational work and in the adjustment of manurial programmes to the requirements of the different soils.

Some 50,000 acres of alluvial soils in the Waimea County have now been covered by detailed soil surveys and classified for flue-cured-tobacco culture. A study of the data derived from the surveys shows that 7,475 acres fall into categories 1 and 2, which are considered good to very good for flue-cured tobacco; some 14,026 acres belong to categories 3 and 4, which are considered more or less satisfactory; and 28,843 acres are regarded as unsuitable for flue-cured tobacco.

A consideration of the total acreage falling into categories 1 to 4 and its present utilization for different crops suggests that there should be no great difficulty in securing an extention in the Waimea County of the flue-cured-tobacco industry to 6,000 acres yearly if prices remain satisfactory.

DISTRIBUTION OF TOBACCO IN THE 1948–49 SEASON

Although it has not been possible to revise the tobacco maps showing the exact distribution of the crop in the Waimea County, a study of the acreages applied for by growers and made available by the Tobacco Control Board shows some changes in comparison with the 1947–48 season and an increase in the 1948–49 season of 148 acres.

(See tobacco soil investigations under Cawthron Institute.)

WHEAT RESEARCH INSTITUTE

Chief Executive Officer: Dr. O. H. Frankel

WHEAT-BREEDING AND WHEATGROWING

As in recent years, the Institute operated on its own station at Lincoln where it has fourteen acres under wheat plots—and on 5 acres of leased land in a high-fertility area at Tai Tapu, about six miles from Lincoln: there were 8,236 plots at Lincoln and 1,247 at Tai Tapu. At the branch station selections are made that are designed for the wheat areas with high fertility in Canterbury and North Otago. In these districts Dreadnought gives high yields, but gives difficulties in harvesting. All the more advanced breeding lines are tested at both stations.

The breeding material included the fifth generation of the cross Hilgendorf × Cross 7, from which it is hoped to select a wheat with the best characteristics of both parents —viz., an all-round high-yielding wheat with highest baking quality. Some of the selections look promising: one had a protein content of 18·5 per cent., which probably is unprecedented in New Zealand.

A heavy attack of mildew (*Erisyphe graminis*) made extensive observations possible on the degree of infection on breeding lines and in the collection. Resistant types were found, and some of these have been crossed with our standard varieties. These studies will shortly be extended in co-operation with the Plant Diseases Division.

Six new lines, from a number of compound crosses, have shown promise in tests at Lincoln and Tai Tapu, and will be included in the regional trials of the Department of Agriculture.

In this year's Extension Division trials the lines 202,01, from the cross (Cross 7 × Dreadnought) × (Cross 7 × Lin Calel), and 192,01, from the cross (64,02 × Cross 7) × (Tainui × Cross 7), again showed good promise. The latter line was found to consist of a number of types, which have been separated and will now be tested individually.

Hilgendorf, the Institute's new wheat, was released during the past season. Seventeen crops were sown, totalling about 220 acres. Reports indicate that with few exceptions farmers were satisfied with the new variety, in spite of the fact that the extended spring drought was a severe handicap for this early-maturing wheat. The seed available for the sowing of 1949 is sufficient for an area of between 3,000 acres and 3,500 acres. To encourage extensive trials by farmers with this high-quality wheat, the Government and the Flour-millers' Society have agreed to a continuation of the premium of 1s. per bushel for the coming year, the millers and the Government each contributing one-half of the premium.

Another new wheat, WRI-Yielder, is not yet ready for general distribution. A nucleus area of 9 acres did not prove sufficiently pure for distribution, and a further reselection has been provided.

Cytogenetic studies of chromosome duplications and multiple mutations in wheat have been concluded, and three papers are in the press overseas. At the invitation of the United Nations, an introductory paper has been written for the United Nations Scientific Conference on Conservation and Utilization of Resources. Studies of the effects of various methods of selection and of the inheritance of quantitative characters in wheat have been continued.

CEREAL CHEMISTRY, MILLING, AND BAKING

The investigation of factors causing the dark crumb colour in bread made from higher-extraction flours has been continued, and, though as yet incomplete, a much fuller understanding of the oxidative processes involved has been attained. This, it is hoped, will be of use in studying the normal dough-maturing mechanism, and the investigation is being pursued with these broader possibilities in mind.

Two or more sacks of Hilgendorf flour were distributed to each of forty-eight bakers for commercial tests. The results have confirmed the laboratory finding that Hilgendorf is a high-quality blending wheat.

The average vitamin B_1 content of the 1948 commercial flours was 3·50 p.p.m. The figure for 1947 was 3·60 p.p.m.

Several hundred wheat hybrids from the Institute's breeding-station were milled and baked as part of the selection procedure. Protein analyses were made on crosses of which there was insufficient wheat for other tests. Milling, baking, and protein tests were made on samples from the Department of Agriculture's wheat variety and manurial trials.

The flour-testing service of the Institute was extensively used by millers to assist them in the control of the baking quality of the 80 per cent. extraction flour. The usual monthly tests on all flours were made for the Wheat Committee. The characteristics of the 80 per cent. extraction flour milled in this year made necessary a change in the standard test-baking process, and, because of the commercial implications of the results of the test, the industries were consulted beforehand. The new test satisfactorily predicts the full-scale performance of 80 per cent. extraction flours.

Following the tendency shown in recent years, many bakers submitted loaves for criticism and advice. Bread from nearly all the bakeries in one main centre have been sent at monthly intervals for report, and in many instances improvement has resulted. Officers visited several districts to assist bakers and millers to overcome technical problems.

One short course for bakers was held, and addresses were given to each section of the bread industry.

At the request of the Wheat Committee and of the Rabbit Destruction Council, the Institute gave technical advice on the milling of a special pollard for rabbit-poisoning.

OVERSEAS VISIT

The chief executive officer, Dr. O. H. Frankel, represented the Department at the Eighth International Congress of Genetics at Stockholm and at a Commonwealth meeting of plant-breeders at Cambridge. He visited many scientific institutions in Britain, France, Belgium, Holland, Sweden, and Denmark, and spent four months at the John Innes Horticultural Institution, Merton, London.

PUBLICATIONS

FRANKEL, O. H.: "A New High-yielding Wheat Variety—WRI-Yielder" *N.Z. J. Agri.*, *76*, 117–119.

———"Hilgendorf Wheat of outstanding Baking Quality." *N.Z. J. Agri.*, *76*, 221–222.

FRANKEL, O. H., and FRASER, A. S.: "Basal Sterile Mutants in Wheat." *Heredity 2*, 391–397.

STERN, ROSA: "Comparative Study of the Effects of Cysteine Hydrochloride and Papain on Unsalted and Salted Doughs." *Cereal Chem. 25*, 220–228.

REPORTS OF INCORPORATED RESEARCH ASSOCIATIONS

THE DAIRY RESEARCH INSTITUTE (N.Z.)

Director: Professor W. Riddet

The Dairy Research Institute (N.Z.), of Palmerston North, which ceased to be a unit of the Department in 1947, now receives an annual grant from the Department.

The survey of the vitamin A content of New Zealand butter has been continued, and the results were generally similar to those of previous years but with some variations in samples from districts affected by unusual weather conditions.

The results obtained in comparisons of washed with non-washed butter from good-quality cream confirm the findings of Danish investigators that there is little difference in its keeping-quality, but it is not yet proved that the results are similar with butter from poor-quality cream.

In the investigations in the temperature of pasteurization of cream in relation to quality of butter, it has been found that with good-quality cream there was some slight advantage in raising the temperature from 202° F. to 208–210° F., but none when raised to 218–224° F. With poor-quality cream there was some slight advantage in pasteurizing at temperatures about 212° F.

Work on the land-cress taint in cream and butter has been continued, but all the treatments have not yet been fully explored.

It has been confirmed that the presence of more than 3 p.p.m. of soluble copper or 4–5 p.p.m. of soluble iron in parchment for butter wrapping increases the rate of development of tallowy off-flavour on the surface of the wrapped butter.

Information of the several processes of continuous buttermaking has been made available to industry; the operation of the heavy-cream concentrator portion of the process was studied, and the physical and other properties of butter produced by the Alfa process were investigated.

As it seemed possible that variations in the amount of "bound water" in milk or curd might afford a clue to the behaviour of different milks during cheesemaking, further investigations have been made of milk samples of different origins.

The Institute has developed to a commercial scale the system of pressing and later wrapping cheese in Pliofilm, and the production of 1 lb. portions reached 160 lb. per day. The product found a ready market.

A number of factories have been assisted by information on the methods of drying buttermilk and whole milk and by analysis of the powders produced.

The maintenance at their highest potential activity of cultures of starters for cheese-manufacturers has become a major task in the laboratories, and a search is also being constantly made for more active strains unrelated in phage reactions to the other stock strains. More evidence indicating that strains of *Str. lactis* are not so suitable for cheese-manufacture, as strains of *Str. cremoris* has accumulated.

"Phage-carrying" starter was submitted to field trials, and a fair degree of success was realized. From the practical point of view, further investigations do not seem worth while, but since the phenomenon of phage-organism symbiosis is of considerable interest, work on the problem may be resumed later.

The results of the survey of cheese-milk quality were examined, and the general conclusion was reached that some undisclosed feature of the manufacturing process was mainly responsible for the differences. The phenomenon merits further study.

Some work on the effect of penicillin in milk on the activity of cheese starter was carried out in view of rapidly increasing use of penicillin for the treatment of bovine mastitis, and it was shown that small quantities are sufficient to inhibit the growth of starter, and to adversely affect the quality of the cheese in other ways.

Experiments have been designed to indicate more precisely the relative importance of various procedures used to control moisture expulsion in cheese-manufacture, and the influence of various factors have been studied.

The gradual improvement in the hygienic quality of New Zealand milk has tended to make the development of a full flavour in cheese more uncertain, since the development of flavour during the ripening process depends on the presence in the milk of lactobacilli which gain access as contaminants. The Institute has shown that it is possible to influence cheese flavour by the addition of cultures of lactobacilli to the cheese-milk or curd, and a study of the growth characteristics and metabolism of the lactobacilli, and their control, has been commenced.

Roquefort-type cheese was made on an experimental scale, and from the distribution of samples there seems to be a significant demand for this. Experimental batches of Cheshire-type cheese were made, and reports from England were for the most part favourable.

The experimental herd was again used in work designed to determine the influence of plane of nutrition during the last two to three months of pregnancy on the subsequent performance of dairy cows. The project was concluded and the report, showing, *inter alia*, that the better-fed animals produced from 23 lb. to 28 lb. more butterfat per annum, was issued.

Five seasons' experimental work on dairy calf nutrition showed that satisfactory calves could be raised on skim-milk without the use of meal. The balance of nutrients was derived from pasture, and the trials clearly demonstrated the value of good-quality pasture in the diet of calves. The calves did not usually develop into animals of high condition at weaning but they grew into excellent yearlings.

Further studies were made to determine the influence of the thyroid gland on milk composition, and no evidence was obtained from the limited number of cases in each trial of any marked consistent influence of the thyroid hormone on the percentage of solids-not-fat content of milk.

Information on the reliability of different weighing procedures was obtained from a summary of the numerous data collected from 1940 on the weights of the Massey College Jersey and Friesian cattle.

The mammary gland secretions of twenty rising two-year-old heifers were examined at weekly intervals to determine if changes in the microscopic appearance of the secretions would provide a reliable indication of pregnancy or of the stage of pregnancy, and it was concluded that no reliable indication was provided without the complete removal of the earlier secretions.

Through the collection of identical twins in the Manawatu and surrounding districts, further progress has been made towards providing more suitable animals for experimental work at the Institute in future years.

NEW ZEALAND FERTILIZER MANUFACTURERS' RESEARCH ASSOCIATION (INC.)

Director: Dr. M. M. Burns

Early in 1949 the Director took up his duties, and progress has been made in the establishment of this research association, which has been an incorporated body from its outset.

A location is being sought for the laboratories, and efforts are being made for their establishment near to the main fertilizer-works and in an area of land that has types of soil representative of the soils of the main districts that use fertilizers.

Studies with radioactive phosphorus in agronomic research have been carried out at the Soil Bureau of the Department of Scientific and Industrial Research, and the Association's beta-ray counter has been loaned for these studies.

A physicist is to be appointed, and he will work in co-operation with the Soil Bureau until the laboratories are established. Major items of equipment for the laboratories have been ordered.

NEW ZEALAND LEATHER AND SHOE RESEARCH ASSOCIATION (INC.)

Acting-Director: Mr. F. G. Caughley

After twenty-one years of activity as a section of the Department of Scientific and Industrial Research, this research association has now (with Cabinet approval) become incorporated under the Incorporated Societies Act, 1908, and is now under the control of a Management Committee representative of the tanning, footwear, and frozen-meat industries and the Department. This development led to increased investigations on problems connected with leather, footwear, hides, skins, tanning-materials, &c.

Fellmongering of Sheep-skins.—An investigation was carried out on the liming of sheep and lamb skins as processed in New Zealand freezing-works. A method of chemically controlling the lime liquors was drawn up and has been used in several works, leading to economies in the use of material and improvement in the pelts. The effects of processing have been followed by microscopic examination of the fibre structure of the pelts.

Leather-manufacture.—A laboratory tanning trial for sole leather, carried out to compare the efficiency of the leather qualities produced by the three unblended tanning-materials of mimosa, myrtan, and myrabolans, indicated that the differences in efficiency (the amount of material that is ultimately taken up by a given amount of hide) show greater contrasts than the qualities of the leather produced by these three materials.

Routine tests on raw materials and finished leathers have been carried out regularly.

Shoe-manufacturers' Problems.—The number of shoe problems submitted to the laboratory during the year was 133 (previous year, 111). The majority of these were from manufacturers on customers' complaints. Perspiration damage during summer months and overheating of wet soles during winter months, and damages in wear from active chemical substances, were responsible for more than three-quarters of the complaints. Quality of material, its selection for a given purpose, or the activity of the wearer were involved in most other complaints. Other problems investigated included the quality of leather-finishes, leather qualities, adhesives, and other accessories in shoe-manufacture.

General.—Contact was made with members by periodical visits to factories, and exchange of publications was carried on with similar research associations overseas.

THE NEW ZEALAND POTTERY AND CERAMIC RESEARCH ASSOCIATION (INC.)

Director: Mr. W. Vose

Owing to the lack of facilities during the early part of the year there was some restriction of activity, but since the completion of the laboratory and the installation of equipment progress in research has been made. The early lack of laboratory facilities, however, permitted frequent consultations with industrialists and visits to works and clay deposits. Sources of information have been established in North America and in United Kingdom.

Research Work.—The raw materials project revealed a wide range of raw materials which by fractionation will give similar plastic and non-plastic kaolins (china clay) to those used in Europe and America. Felspathic rock was indicated in a few localities; this, by mineral dressing, would give a suitable felspar supply for white New Zealand porcelain or earthenware.

Information upon New Zealand clays was fully indexed, and the selection of clay sources for china clay were made. The possibility of New Zealand ball clays was considered, but there is no prospect yet of good ones. The best are of relatively poor quality and it is considered that a wider use of plastic kaolin would ease this difficulty.

The fundamental study of the relationship between the constituent properties and body properties (fired and unfired) in the felspar-quartz-clay field has proceeded to the stage of preparation of precise standard body components, and the development of techniques for ceramic experimentation on a scale of 20–100 gm. This has been necessary through the absence of any previous reported work in this field.

Test methods of value to ceramic research and industrial control have been critically examined, such as particle size determination, mineralogical analysis by thermal analysis methods, spectrochemical analysis for Fe_2O_3, CaO, alkalies, &c.

General.—Many projects of smaller scale have been commenced, such as the listing and assessment of pottery plasters, and the nature of grinding pebbles and cylinder linings for grinding-mills.

Papers have been presented by the staff and members of the Technical Committee on "Physico-chemical Aspects of Ceramics," "The Part of Ceramics in Modern Life and Industry," "The Theory and Practice of the Andreasen Pipette Method of Particle Size Analysis," "The Testing of Glazes on Domestic Wares," and "The Physical Testing of Electrical Porcelain Glazes."

The circulation of literature—not published in the usual journals—from outside New Zealand has been the only contribution so far possible in the nature of an information service.

NEW ZEALAND WOOLLEN-MILLS' RESEARCH ASSOCIATION (INC.)

Director: Professor F. G. Soper

Numerous problems submitted by the mills, Government Departments, &c., have been dealt with, besides the routine tests for shrinkage, grease contents of scoured wools, &c. A number of fibre-fineness measurements were carried out on greasy wool and tops to check a mill's standards for fineness in buying and uniformity in sorting wool. The formation of neps during carding was investigated, and some preliminary trials made. A considerable number of miscellaneous faults caused in the mill or after the material has left the mill have been investigated, and these usually required individual treatment.

Facilities for technical education in the textile industry by means of correspondence courses were devised, and the initial parts of some of the courses were nearing completion.

The Dri-Klor certification mark, to be reserved to manufacturers in New Zealand, was accepted by the Patent Office, and registration automatically followed.

A considerable number of visitors, including some from overseas, inspected the research work in progress at the laboratories.

Two bulletins were issued during the year in which many papers of technical interest appeared.

RESEARCH INSTITUTE OF LAUNDERERS, DRY-CLEANERS, AND DYERS OF NEW ZEALAND (INC.)

Cabinet approved the incorporation of the Institute with an assurance of a pound-for-pound subsidy on contributions.

In view of the difficulty of securing a suitable person to direct the Institute's activities, the Management Committee decided to select a New Zealand graduate and train him here and overseas to fill the senior technical position.

Problems requiring scientific assistance have in the meantime been referred to the Dominion Laboratory or to the appropriate overseas organization. These included damage to surgeons' gloves; washing and shrinkage of woollens, including blankets; suitability of starch extender; and layout of new laundry. The Fuel Efficiency Service supplied by the Dominion Laboratory has been of great assistance to many members. Difficulties having been experienced by importers of laundry machinery clothing, necessary

sponsorship of outstanding orders was secured. An examination of filter aids for dry-cleaners, made in collaboration with the Dominion Laboratory, showed that a substantial proportion of imported filter aid was essential, and that local diatomaceous earths were suitable in admixture only if treated in a similar manner to the overseas earths. Representations were made and importation of adequate quantities of filter aids was permitted.

Reciprocal arrangements have been concluded with the leading institutions in the United States of America, Canada, United Kingdom, and Australia, and these have proved of great benefit.

The total membership was 65, including almost all of the Hospital Boards.

CAWTHRON INSTITUTE

Director: Sir Theodore Rigg

The reports of investigations on soil, plant nutrition, and entomology, and the research on tomatoes and fruit, at the Institute are given below. Other work of the Institute appears under "Hop Research" on page 58. Further reports on tobacco research appears on page 60, on entomology on page 30, and on fruit on page 33.

ENTOMOLOGICAL INVESTIGATIONS

Potato Tuber Moth.—The influence of cultivation upon the infestation of a potato crop by the potato tuber moth (*Phthorimaea operculella*) was studied. Two areas of Sutton Supreme were used, in one of which the rows were moulded according to custom, while the other was left unmoulded though kept free of weeds. From the moulded area 280 lb. of potatoes were harvested, and from the unmoulded 180 lb., while 7 per cent. of the former and 35 per cent. of the latter were grub-infested. This demonstrated the necessity for adequate cover and depth for the production of a crop and for its protection. As the tuber moth causes considerable loss of tubers throughout New Zealand both in the field and after harvesting, together with extensive damage at times to the foliage during growth, the introduction and rearing of parasites is being undertaken.

St. John's Wort.—The establishment of the St. John's Wort beetle (*Chrysolina hyperici*), secured originally from Australia, is very satisfactory, and the insect is giving excellent control of the weed in areas after two years or so from the time of its liberation. In the Upper Awatere Valley, where the original establishment was secured, approximately 400 acres had been cleared of the weed by the close of 1947, and by the close of 1948 the cleared area had extended far beyond those bounds. The cleared land is now in pasture. On an area near Arrowtown where liberations were made in 1946 the experience of the Upper Awatere is being repeated, and there are definite indications of a similar state of affairs taking place in other parts. The insect has so far been liberated only over the South Island, but this year it will be sent to the North Island. Reports from Otago indicate that the beetle is also attacking Tutsan (*Hypericum androsaemum*) in the field as well as St. John's Wort (*Hypericum perforatum*), and if this continues the results will be of great economic value in having both weeds under control.

Chilean Saw-fly.—This insect (*Antholcus varinervis*) apparently has not yet managed to establish itself in the field. The colony in the Institute insectary, however, maintains itself abundantly, and requires considerable attention owing to its food-supply being rapidly eaten out. This demands hand-feeding of the larvæ, the surplus of which is liberated in the field.

Steel-blue Horntail Parasite.—The annual routine distribution of the *Rhyssa* parasite of the larvæ of the Horntail borer (*Sirex noctilio*) of pine-trees has been carried out, 704 females having been sent to Canterbury and Taupo plantations. This work entails heavy labour in the felling of infested trees, cutting of logs, and setting them up in insectaries, where the emerging *Rhyssa* are collected. In addition, each year a check is kept of the proportion of *Rhyssa* and *Sirex* that emerge from the logs.

In co-operation with the State Forest Service, the introduction of the *Ibalia* egg parasite of *Sirex* is being attempted.

Analysis of Food of Birds.—In connection with the survey of the food of certain birds being carried out by the Animal Ecology Section, examination has been made of the stomach contents of sixty-seven birds from the agricultural areas of the Auckland Province. Amongst this material several species of insects not previously recorded in New Zealand have been found. A report on the investigation has been drawn up.

Collections. The insect collections have been overhauled and considerably expanded, necessitating more accommodation for the specimens. This involves sorting, setting, and card indexing of material in order to place the records on a proper basis. Collections and manuscripts of the late Mr. A. L. Tonnoir and Mr. A. F. Clark have been dealt with.

Library.—The routine duties associated with the maintenance of the entomological library and the handling of new accessions has been carried out, together with the extensive task of checking, in readiness for publication, all of the 3,000 references in the manuscript of the "Bibliography of New Zealand Entomology."

FRUIT RESEARCH

Magnesium Deficiency of Apples.—The experimental plots show that Cox's Orange and Sturmer trees at Tasman continue to give satisfactory response from the use of ground dolomite, but at Braeburn, possibly because of the abnormally dry summer, the use of magnesium compounds has not entirely overcome leaf-blotch and the early fall of apple-leaves on the Sturmer variety.

Zinc Deficiency Tests.—To obtain information on the value of zinc sprays for typical orchards on the Moutere Hills soil, experimental plots have been established in five orchards at Tasman and Mariri. Dormant zinc sulphate sprays at 5 per cent. and 2½ per cent. were used on Gravenstein, Sturmer, and Jonathan varieties of apples, but with no noticeable benefit. Analyses of apple-leaves collected in different orchards show no evidence of wide-spread zinc deficiency.

With certain cherry-trees affected with "die-back" in a Tasman orchard, the effect of zinc sprays on the zinc content of the leaves was quite marked. The trees appeared to benefit considerably, but further work is required to ascertain whether other minor element deficiencies are connected with "die-back" in cherries and other stone-fruits on Moutere soils.

Copper Deficiency in Apple-trees.—Experimental plots in an orchard at Harakeke, where the Jonathan trees not only set fruit very poorly but have a weak foliage development, showed copper deficiency to be a very important factor. A Bordeaux spray applied in the spring resulted in very marked improvement not only in foliage, but also in set of fruit. Experiments are to be continued next season to secure more information.

Raspberry "Die-back."—"Die-back" was very prevalent in many raspberry-gardens, and since the possibility of boron deficiency occurring on raspberry soils had been suspected by the Institute two years previously, experimental plots with boron and other minor elements had been established in the Motupiko and Tadmore district. In the first season no pronounced benefit resulted, but this season the boron plots were outstanding in development of fruiting spurs and foliage, in striking contrast to the poor growth on non-boron-treated plots.

Further treatments with borax at the rate of ½ oz. per raspberry-bush have been made in several gardens to secure confirmation of these beneficial effects. Leaf samples from treated and untreated raspberry-bushes have been obtained and will be examined for boron content at an early date.

Raspberry Manurial Trials.—These comprise tests, in two gardens, with fertilizer mixtures with and without potash to ascertain the value of potassic manures. Supplementary tests with boron, magnesium, manganese, zinc, and copper are being conducted

in gardens at Rakau and Motupiko. The occurrence of "die-back" in raspberries this season has interfered with the conduct of the main fertilizer trials in one garden, but in the other the complete manure and complete plus extra potash gave very good results. It is interesting to note that raspberries are susceptible to chlorine injury and this season considerable "leaf-scorch" occurred from the use of muriate of potash.

Besides the good results obtained with borax, copper has given improved growth of foliage. Manganese appeared to give some improvement in the general condition of the raspberry-bushes, but zinc seemed to be detrimental. Further treatments with copper sulphate have been arranged.

Plant-food Status of Permanent Manurial Blocks at the Appleby Research Orchard.—An attempt has been made to secure more information concerning penetration of phosphate in the soil by extraction with strong hydrochloric acid, and considerable increase in the content of phosphoric acid in the 0–6 in. depth and the 6–12 in. depth of soil was shown. There was little, if any, recovery of added phosphate below the 0–12 in. depth. In two treatments containing superphosphate, the amount of phosphoric acid (P_2O_5) increased 0·07 per cent. in the 0–6 in. depth and 0·014 per cent. in the 6–12 in. depth as a result of fourteen years' treatment.

Characteristic Symptoms of Plant-food Deficiencies in Dougherty Apples.—Trees receiving P + N treatment for twenty years show pronounced "die-back." The leaves are small and are light green in colour. Little if any "scorch" of the leaves was seen this season, which was rather dry. In addition to pronounced "die-back" of the trees, the most noticeable feature of potash deficiency is the small size of the fruit and its poor colour. Trees which received K + N treatment show "die-back," but not so pronounced as with P + N treatment. The leaves are dark green with a purple tinge and with a red pigmentation of the leaf stalk. The fruit is of good size and colour. Trees with K + P treatment show very little "die-back," but growth is very short or absent. The leaves turn yellow much earlier than with the complete treatment. Fruit ripens early and is of fair size and highly coloured. Trees with complete treatment still make good growth. The leaves are bright green and of good size. Fruit tends to be later and lacks the high colour of the K+P treatment. Trees with complete treatment are now outstanding both in growth and yield of fruit.

Apple Stock Experiments at Annesbrook Orchard.—Tests of Double Vigour (French Crab vegetatively propagated) for the Statesman variety continue to show to advantage over Northern Spy stock. The total yield for the last five years shows 1,058 lb. per tree for Double Vigour, and 835 lb. per tree for Northern Spy.

A vegetatively propagated stock derived from Epps' seedling has given much greater growth with Cox's Orange and Jonathan varieties than has Northern Spy Stock.

"Die-back" of Apples in the Tasman District.—Work is being continued on the fungi associated with fireblight cankers. Further information on the wide distribution of "white heart-rot" fungus (*Polystictus versicolor*) has been obtained.

Control of Black-spot of Pears (Venturia pirina).—In a spray test carried out on the susceptible Glou Morceau variety, the advancement by ten days of the first Bordeaux spray to coincide with the time of maturation of ascospores appears to have given improved control of black-spot.

Raspberry Diseases.—A survey of diseases affecting raspberries in the Tapawera and Riwaka districts has been made. Detailed examinations are being continued in three gardens where unusual disease symptons were found.

(See also "Fruit Research Station" on page 33.)

PLANT NUTRITION INVESTIGATIONS

COLORIMETRIC ESTIMATION OF ZINC IN PLANT MATERIAL

The colorimetric method (devised by Cholak, Hubbard, and Burkey) has been tested for the estimation of zinc in plant material. This method is based on the intensity of red coloration obtained with di-beta naphthylthiocarbazone and zinc. Experience showed the prime importance of purification of all reagents and the thorough cleansing of all apparatus used in the determination.

The greatest care was found necessary at every stage in the determination to avoid contamination from casual sources of zinc and to secure complete extraction of zinc.

Determinations made by the colorimetric method compare very favourably with corresponding determinations made by the polarograph method. Seven determinations of zinc in apple-leaf samples made by the Dominion Laboratory, Wellington, agreed satisfactorily with colorimetric determinations made on the same samples at the Cawthron Institute.

ZINC CONTENT OF APPLE-LEAVES AND FRUIT SPURS

With a view to securing information concerning the distribution of zinc in different types of apple material and at the same time obtaining suitable standards for comparison, samples of leaves, fruit buds, spur bark, spur wood, leader bark, and leader wood, obtained from several varieties of apple-trees, have been analysed for zinc contents.

The varieties of trees examined in this way included Gravenstein, Sturmer, Jonathan, and Cox's Orange. The samples of apple material were obtained from typical orchards at Mahana, Tasman, Braeburn, Redwood's Valley, Waimea West, Riwaka, and Stoke.

The leaf samples were collected at a different period and from different trees to those from which the fruit buds and other samples were obtained. On this account the zinc contents of apple-leaves are not strictly comparable to the zinc contents of the fruit buds, spur bark, &c.

In the leaf samples a variation in zinc content from 16·25 p.p.m. to 27·6 p.p.m. was obtained for eight samples of Gravenstein leaves collected from different orchards in the Nelson district, the average being 22·3 p.p.m. In the Sturmer variety, four leaf samples gave an average zinc content of 34·8 p.p.m. on the dry matter, the variation being from 28·2 p.p.m. to 40·4 p.p.m. In three Jonathan leaf samples, the variation in zinc content was from 34·4 p.p.m. to 44·7 p.p.m.

Fifteen samples of fruit buds, spur bark, spur wood, leader bark, and leader wood obtained from Gravenstein, Sturmer, Jonathan, and Cox's Orange trees were analysed separately for zinc content. As the samples of different types of apple material were obtained from the same trees, the zinc contents provide information concerning the distribution of zinc in different parts of the fruit spurs.

The determinations showed very marked differences in the zinc content of the different types of apple material. The average zinc contents for the fifteen samples were as follows: fruit buds, 83 p.p.m.; spur bark, 271 p.p.m.; spur wood, 84 p.p.m.; leader bark, 69 p.p.m.; and leader wood, 34 p.p.m., on the dry basis. Leader wood had the lowest zinc content, resembling fairly closely the zinc content of apple-leaves. The highest zinc content was found in spur bark, but very great variations in different samples occurred, the lowest zinc figure for this type of material being 81 p.p.m. and the highest 501 p.p.m.

No clear indication was obtained from the samples analysed of any association of higher zinc content with any one of the four varieties of apples or of great variation in zinc content due to location of the orchards.

POT CULTURE TESTS

A start has been made in the organization of pot culture tests with different indicator plants for minor element deficiencies on two selected Nelson soils. Reagents to be used in nutrient solutions have been examined for contamination with different minor elements. Quartz sand and the two selected Nelson soils have been examined for minerals, including content of manganese, iron, zinc, and copper. The town supply has been selected as the best available for the watering of the pots. This water is very low in copper, zinc, manganese and iron—all elements that will be investigated in the pot culture tests—and it contains relatively large amounts of calcium and magnesium. After purification by passing through a demineralizing unit, a satisfactory reduction in both calcium and magnesium was obtained, and the contents of copper, zinc, and iron were lowered to 0·007 p.p.m., 0·057 p.p.m, and 0·090 p.p.m. respectively.

SOIL INVESTIGATIONS

TOBACCO SOIL

Tobacco Soil Surveys.—The soil survey of the Stanley Brook Valley has been completed, and tobacco soil maps of this area and the Tapawera locality have been prepared and made available to the Tobacco Board and interested organizations. Base maps have been secured of a small area covering the Baton and Dove River locality, and it is hoped to finish field-work on this area at an early date. This will complete the survey of all alluvial soils in the Waimea County climatically suited to flue-cured tobacco.

In view of marked differences in chemical chracteristics of alluvial soils resulting from the nature of the parent material from which the soils have been derived, it has been found desirable to show on the tobacco soil maps not only textural differences, but also origin of the parent material.

A summary of the acreages of potential tobacco land in different categories has been prepared and estimates made concerning the further development of the flue-cured-tobacco industry in the Waimea County.

Chemical Analyses of Tobacco Soils.—Chemical data have been completed for fifty-nine samples of soil collected from fields actually used for tobacco. The soils are representative of five major soil groups in the Waimea County, and show marked differences in base status and content of available plant-food.

In general, the analyses show that all tobacco soils are high to very high in available phosphate. This is particularly marked in the Motueka-Riwaka district and in the lower Motueka valley. The potash contents of the tobacco soils, on the other hand, show medium to rather low figures. This is in keeping with the good results that have been obtained at the Tobacco Research Station from the use of potassic manures for flue-cured tobacco on sandy soils.

The soils show wide variation in acidity. The base saturation of individual samples of tobacco soil varies widely from 17 per cent. to 93 per cent., but the majority have a base saturation of 50 per cent. to 60 per cent.

There are marked differences in the content of exchangeable magnesia in different soils. Low figures are associated with all soils derived mainly from granite at Umukuri, Sandy Bay, Pangatotara, Baton, Graham, Pearce, and Stanley Brook valleys. Dune sands, too, are low in this base, but high figures are associated with tobacco soils at Tapawera.

Considerable variation was found in the nitrogen content of tobacco soils. A great number of sands and sandy loams ranged from 0·08 per cent. to 0·12 per cent. total nitrogen, but there were several samples of sandy loams and light phase silt loams which contained up to 0·25 per cent. nitrogen.

(See also " Tobacco Research " on p. 60.)

TOMATO SOILS

Nitrogen Status of Tomato Soils.—Studies relating to the effect of steam, soil disinfectants, and different types of nitrogenous fertilizers on the available nitrogen level of Nelson tomato soil have been continued, and the results from the previous year have been written up for publication. Some of the more important conclusions are summarized as follows: Sterilization by chloropicrin at the rate of 4 c.c. per square foot delayed nitrification some five to six weeks compared with steam treatment of the soil. On this account nitrogen applied as sulphate of ammonia or dried blood to chloropicrin-treated soils remained mainly in the form of ammonia for some ninety days after the application of the fertilizers. Steam and chloropicrin treatments of the soil both raised the level of available nitrogen in the soil, steam treatment being more effective than chloropicrin in this respect.

TOMATO RESEARCH

In certain cases the results given below relate only to one season's work, and caution should be exercised in their application to commercial tomato culture. Where investigations have been carried out over a number of years, a summary giving the more important conclusions has been included.

TESTS WITH STEAM AND SOIL DISINFECTANTS

These have comprised tests with steam, chloropicrin, and D-D under glasshouse conditions, and trials with chloropicrin and D-D in outside tomato gardens.

For the third year in succession, chloropicrin, used at the rate of 36 c.c. per square yard, gave a result equal to that obtained with steam treatment of the soil. D-D used at the rates of 27 c.c. and 45 c.c. per square yard respectively also gave a satisfactory improvement in yield, but not quite so good as with chloropocrin. Tomatoes grown on the D-D plots were affected with a distinct flavour that sometimes was rather objectionable. Typical yields from the different treatments are as follows: unsterilized, 5·2 lb.; steam, 8·6 lb.; chloropicrin, 8·6 lb.; and D-D, 8·3 lb., per plant.

With the exception of the flavour shown in tomatoes grown on the D-D treated plots, quality of tomatoes was similar in the case of steam, chloropicrin, and D-D treatments.

Good results, likewise, were obtained with chloropicrin and D-D in the treatment of outside tomato soil. The result was pronounced in the case of chloropicrin: not only was there a marked improvement in the growth of the plants, but yield and quality of tomatoes was beneficially affected. In one experiment the increase in yield, averaged over six plots, was 0·6 lb. per plant. In a second experiment the increase in yield with chloropicrin treatment was as much as 2 lb. per plant. In the case of D-D the increase in yield was not so marked, and the tomatoes frequently had an undesirable flavour.

The association of a peculiar flavour with tomatoes grown on Nelson soil treated with D-D requires further investigation. The soil used for the experiments was a heavy loam, which presents difficulties in the quick elimination of chemical products arising from the use of soil disinfectants. It is possible that greater aeration of the soil, and a longer interval between treatment of the soil with disinfectants and the actual planting of the crop, may greatly reduce or eliminate the occurrence of undesirable flavour in the crop.

VALUE OF COMPOST, SAWDUST, ETC., FOR GLASSHOUSE SOIL

Experiments have been continued to ascertain the value of compost, sawdust, and cocoa-bean husks in the treatment of glasshouse soil. Compost used at the rate of 15 tons per acre again gave very good results in improving yield of the crop. Sawdust, which was applied in the 1945 season at the rate of 30 tons per acre, no longer

detrimentally affected the growth of the tomato plants. The yield, however, showed no improvement over that from the control plot, nor was the quality of tomatoes improved.

Cocoa-bean husks, used on unsterilized soil at the rate of 15 tons per acre in three successive seasons, have given a decided improvement in yield over the corresponding unsterilized plot without cocoa-bean husks.

Typical yields for the above treatment are as follows: sterilized soil with compost, 9·0 lb.; sterilized soil with sawdust, 8·1 lb.; sterilized soil (control), 8·2 lb.; unsterilized soil, 5·2 lb.; and unsterilized soil plus cocoa husks, 7·0 lb., per plant.

This season a very marked improvement in quality of tomatoes was obtained on plots treated each year with an additional 1 ton of potassic manure per acre. The yield, however, with this treatment showed no increase over that from the standard formula.

USE OF NITROGEN FOR GLASSHOUSE TOMATOES

Tests have been carried out concerning the value of repeated small doses of nitrogenous manure compared with the standard procedure in which one-third of the nitrogen is applied before planting and the remainder given in two dressings during the growth of the plants. The value of greatly increasing the quantity of nitrogenous fertilizer was also tested on one plot. Little difference in yield of tomatoes was obtained with these variations in the use of nitrogen under the particular conditions of the experiment. Quality of fruit appeared to be slightly improved with the large dressing of nitrogenous manure. Typical yield results are as follows: standard procedure, 11·8 lb.; frequent small applications of nitrogen, 11·6 lb.; extra nitrogen, 11·8 lb., per plant. The experiment was carried out on steam-sterilized soil, and the total quantity of nitrogen for the standard treatment and the more frequent application of nitrogen was the same.

EFFECT OF LATE PLANTING ON YIELD AND QUALITY OF TOMATOES

This year a plot of Potentate tomato plants was planted on 9th October for comparison with corresponding plots planted at the normal planting date, 22nd August. Although the tomato plants in the late planting suffered to some extent from mosaic infection, they grew extremely well, and began to ripen only a fortnight later than the fruit of the August planting. Although the yield (9·3 lb.) from the late-planted plot was considerably lower than the yield (11·4 lb.) of the corresponding plot planted in August, the quality of the tomatoes showed great improvement, no less than 70 per cent. being of first grade, compared with less than 40 per cent. for the August planting. This result confirms the experiment on "cloud" reported in the previous season, when late-planted tomatoes showed 1·1 per cent. "cloud," compared with 9·1 per cent. for the August-planted crop.

VARIETY TESTS

Six varieties of tomatoes, five of which were obtained from the Cheshunt Station, England, were tested under glasshouse conditions, using a standard manurial programme on steam-sterilized soil. The varieties comprised Invincible, Mayland Beauty, Potentate, Queen, E.S.1, and E.S.5. Of these varieties, Mayland Beauty, E.S.1, and E.S.5 have somewhat small fruit, and may require heated glasshouse conditions to secure the best results.

Potentate and Queen varieties showed similar characteristics. Yield of tomatoes was 11·6 lb. and 11·9 lb. per plant respectively, and quality of tomatoes was better than that of Potentate (New Zealand) grown in another glasshouse. Mayland Beauty, which has somewhat similar characteristics to E.S.5, likewise gave a very good yield of

11·8 lb. per plant, but the quality of fruit was not equal to that of E.S.5. The Invincible variety gave fruit of good size, shape, and quality. The crop, however, was late, and the yield of 9·1 lb. per plant was considerably below that of Potentate.

The E.S.5 variety did better than in the previous year: the yield of 11·1 lb. per plant was good, and the quality of the tomatoes was excellent, but a rather high proportion of small fruit was a disadvantage. The E.S.1 variety was the least satisfactory of the varieties tested.

The above varieties, together with Hall's, Hutt Special (Kidson), and Kondine, were tested under outside conditions of culture on two different soils. Dry weather militated against the best results being obtained, particularly in one garden where watering of the plants was not possible.

The highest yield in these field tests was obtained with Hutt Special (6·4 lb.) and Kondine (6·3 lb.), followed by Queen (5·3 lb.). Other varieties ranged in yield from 5·1 lb. to 5·3 lb. per plant. Potentate (New Zealand), with a yield of 4·8 lb. per plant, gave the poorest result.

Quality of tomatoes was best with Invincible, Mayland Beauty, Hall's, and E.S.5, and poorest with Queen and Potentate.

"HARD-CORE" INVESTIGATIONS

Further evidence has been obtained concerning the importance of chloropicrin and of potassic manures in reducing the amount of "hard-core" in tomatoes grown on Nelson soil. The results of the past season's work on "hard-core" are discussed below.

Effect of Chloropicrin and D-D on "Hard Core."—Two experiments on somewhat different types of soil in the grounds of the Institute (Nelson) were conducted, using chloropicrin for soil disinfection in one experiment and D-D as well as chloropicrin in the other experiment.

In the first experiment, chloropicrin was used at the rate of 36 c.c. per square yard on a number of plots treated in previous years in different ways, and corresponding plots without chloropicrin treatment were available for comparison. Determinations of "hard-core" in Kondine tomatoes grown on the experimental plots showed, over the six comparisons that were available, a reduction in the amount of commercial "hard-core" of 44 per cent. on the plots treated with chloropicrin. The average percentage of "hard-core" was 24 per cent. on the chloropicrin plots and 68 per cent. on the plots without soil disinfectant.

The previous treatment of the plots influenced to some extent the final result obtained with chloropicrin. Thus plots treated previously with cocoa-bean husks showed the least "hard-core" (14 per cent.), compared with 36 per cent. "hard-core" in plots receiving in previous years only standard fertilizer.

In a second experiment, carried out on a soil not so conducive to "hard-core," replicated plots were treated with chloropicrin, D-D, compost, and mulch respectively. Each plot received the same fertilizer mixture. Both chloropicrin and D-D proved beneficial in reducing "hard-core," but compost and mulch had little if any effect.

Effect of Potash, Lime, &c., on "Hard-core."—Plots were available with heavy dressings of potassic manures (1 ton sulphate of potash per acre), of slaked lime (2 tons per acre), and sulphur (2 tons per acre). In each case a standard fertilizer was used over all plots, and determinations of "hard-core" were made at a favourable opportunity during the harvest season. The soil on which the experiment was conducted was known to be associated with a high percentage of "hard-core" in tomatoes.

The results showed the following percentages of commercial "hard-core" with the different treatments: heavy potash, 12 per cent.; lime, 30 per cent.; sulphur, 46 per cent.; control, 47 per cent. The "heavy-potash" plot had received additional

potassic manures in previous years. The results show clearly the beneficial effect from the use of large amounts of potassic fertilizers. Lime appears to have had some effect in reducing "hard-core," but sulphur had no effect.

The highly beneficial effect of potassic manures in reducing "hard-core" was confirmed in at least two other experiments conducted in the grounds of the Institute. It is interesting to note that the best result was obtained when the standard fertilizer was supplemented with extra nitrogen in addition to extra potash.

A summary of the results of investigations on the incidence of "hard-core" shows:—

(1) Nelson clay loam, used extensively for tomato culture, is more prone to high incidence of "hard-core" than many other Nelson soils.
(2) Great reduction in the amount of "hard-core" results from the use of chloropicrin and D-D on this soil.
(3) Great reduction in "hard-core" is associated with heavy potassic manuring of tomatoes.
(4) Lime treatment of Nelson clay loam appears to be beneficial, but sulphur is ineffective in reducing "hard-core."
(5) Organic fertilizers such as sheep manure and cocoa-bean husks are beneficial in reducing "hard-core."
(6) The use of extra nitrogen with heavy potassic manuring on Nelson clay loam gives greatest reduction in "hard-core."

(See also Plant Diseases Division, page 49, and Canterbury Agricultural College, page 81, reports on tomato diseases.)

UNIVERSITY COLLEGES

Grants were made by the Department to Canterbury and Massey Agricultural Colleges and to Canterbury University College.

CANTERBURY AGRICULTURAL COLLEGE

ANIMAL HUSBANDRY

Professor I. E. Coop

Pig-breeding.—The addition of the Johnston Large White strain to the existing "Lincoln Red" pigs reached the second generation. The original difficulty of extension of black spots again appeared but is expected to become restricted in the next generation. Pigs from the new strain continued to fare well in "bacon carcass" competitions.

Sheep-dipping Trials.—The trials have been continued, but the projected tests against shoulder blow-fly strike have lapsed because no strike occurred in Canterbury during the season.

Sheep-breeding: Progeny Testing.—In progeny tests on Corriedale sheep, the first was completed, the second was in progress, and the third commenced. Progeny testing in Romney and Corriedale stud flocks was continued. Data for the study of factors, other than inheritance, affecting fleece-production were completed, and studies of the inheritance of breed type, prolificacy, and growth rate were continued. The growth and development study of Corriedale sheep was completed, and the breeding performance of the two groups (high plane and low plane of nutrition) was studied.

Ruminant Digestion Studies.—The toxicity of cyanogenetic glucosides to sheep was measured, and a paper on the completed work was prepared. The study of the effect of starvation and of the recovery from starvation as measured by microfloral activity

in the rumen of sheep was completed, but as certain limitations arose in the interpretation of the results further studies were made. A start was made on determining the metabolism of nitrate in the rumen of sheep, and methods of analysis are being perfected.

Dairy Cattle.—A small group of identical twins is being assembled for experimental purposes.

SOIL FERTILITY INVESTIGATIONS

Mr. H. D. Orchiston

This was the first season in which cultivation treatments were applied. All rotation cultivation and fertilizer treatments were established, and the smooth operation of plot technique developed.

Pastures.—Both the good and the poor first-year pastures established well, and were about equally grazed. The differences between good and poor were most marked when suffering from drought: the good pastures showed superior red clover, greater grass potential, and less bare ground. The second-year pastures showed very little difference, except for a greater grass potential in the good pasture plots when suffering from drought.

Spring Crops.—Cross 7 wheat had an unsatisfactory season, through initial bird damage and a dry period of growth. Only straw weights were recorded, and these were less than a third for those of autumn wheat (with fertilizers). Partridge peas and Research barley plots gave yields appreciably higher than in the previous season.

Autumn Wheat.—Both with and without fertilizers the autumn wheat had uniform growth; bird damage was recorded and accounted for. Yields were good—60 bushels of grain and 5,000 lb. of straw per acre—despite a total of 12·4 in. of rain from sowing to harvesting, and almost twice this evaporation (free water surface).

Results of Analysis.—Replication I showed significantly lower green yields for spring wheat of the first-year crops (1 per cent. level) and for autumn wheat of the second-year and fourth-year crops (5 per cent. level) than Replication II. Rotations were significantly different (1 per cent. level) for the second-year crops, autumn wheat after peas being greater than after spring wheat. Significant differences (5 per cent. level) were obtained for barley in the third-year crops. Of the fertilizers, only lime gave a significantly higher yield than the control, but this may have been caused by replication differences. In no cases did cultivation treatments, or "a and b ½ blocks," give significant differences.

Methodology for Soil Properties.—A soil-sampling procedure was established. Both physical and chemical determinations were made to standardize the method and to determine the number of samples to be taken to make up a composite representative sample.

ENTOMOLOGY

Mr. L. Morrison

Hessian Fly.—In the seasonal observations on the infestation of wheat and barley by Hessian fly, the numbers of barley samples obtained were far too few and from too restricted an area to supply reliable results. Hessian-fly material was sent to Rothamsted to determine whether the fly occurring on wheat is the same variety as that on barley.

Insect Fauna of Red Clover.—An investigation was started with the main object of determining the effect of insect pests of red clover on the seed yield, and more especially of the effect of thrips (erroneously termed "red mite").

Porina Investigation.—Considerable progress was made in determining the effect of different degrees of temperature and percentages of humidity on the period of incubation and percentage hatch of eggs of *Porina* moths.

SUBTERRANEAN CLOVER

Mr. J. W. Calder and Mr. C. E. Iverson

The particularly dry season adversely affected the grass and clover growth in the investigations at Ashley Green.

For the twelve months ending 8th February the production of dry matter per acre was as follows :—

Treatment A (2 cwt. super. per annum) : Average of six plots, 2,299 lb.

Treatment B (5 cwt. lime per annum alternating with 1 cwt. super. per annum) : Average of six plots, 2,449 lb.

Treatment D (1 ton of lime initially and 2 cwt. of super. and ½ cwt. of potash annually) : Plot 1, short-rotation rye-grass, phalaris, and subterranean clover, 5,660 lb. ; Plot 2, short-rotation rye-grass, lucerne, phalaris, and subterranean clover, 4,916 lb. ; Plot 3, perennial rye-grass and subterranean clover, 4,370 lb. ; Plot 4, cocksfoot, lucerne, and subterranean clover, 4,285 lb. ; Plot 5, cocksfoot and subterranean clover, 3,868 lb. ; Plot 6, various, 409 lb.

The differences between treatments A and B were non-significant this season ; D-treatment plots were higher, as was to be expected in first-year pastures. Short-rotation rye-grass had given especially high results, but cannot be expected to continue. The phalaris was smothered when sown with short-rotation rye-grass, which in future investigations will be omitted.

FARM MACHINERY

Mr. A. W. Riddolls

Harvesting of Small Seeds.—The previous season's trials of harvesting white-clover seed with mower fitted with specially designed windrows, of threshing white clover, and of topping of rye-grass, were repeated. Seed-damage trials were also made on red clover, and raking in high winds was made possible by fitting a specially designed roller to the side rake. None of these investigations had been carried far enough for definite conclusions to be made.

Rotary Pasture-topping and Weed-cutting.—More development work is required on the tractor-mounted rotary topper, which appears to have definite possibilities for pasture-topping and weed-cutting.

Mechanical Ditch-cleaning.—Further trials were continued with a power-driven continuous-acting tractor-mounted ditch-cleaner of original design. Modifications were made which had given improved operation, particularly in cutting heavy growth on the far bank of the ditch. The design of the machine had yet to be finalized.

MICROBIOLOGY

Dr. I. D. Blair

Plant Disease Survey

Tomatoes Under Glass.—In the Christchurch area 52 glasshouses were under observation for the third season. The average infection of Verticillium wilt was 12 per cent. (*Verticillium dahliæ*). Over all houses wilt incidence in relation to soil treatment had been distributed as : steam sterilized, 2·8 per cent. ; formalin, 50 per cent. ; and no soil treatment, 100 per cent. Very unsatisfactory control existed with formalin treatments which are still used very widely. Highly satisfactory results relating to soil disease were obtained by the very few growers using chloropicrin and D-D treatments.

Leaf mould (*Cladosporium fulvum*) was present in all glasshouses and severe in some cases—*e.g.*, in low-gabled houses or where ventilation was restricted. The disease seemed to warrant general adoption of a spray schedule in the Christchurch area. Grey mould (*Botrytis cinerea*) caused damage to either leaf, stem, or fruit in a quarter of the houses,

while the ghost-spot phase infected in some instances 10 per cent. of the fruit. A collar-rot condition affecting up to 10 per cent. of plants was associated with *Botrytis cinerea* where tomatoes had been mulched with pea-straw. Foot-rot (*Phytophthera cryptogea*) occurred in two houses. There were no severe infections of mosaic or spotted wilt under glass, but spotted wilt was found in outside crops up to 12 per cent. Tomato-streak virus was recorded at 1 per cent. in several houses.

Leaf-mottling of Tomatoes.—A widely-occurring condition was characterized by yellow inter-venal discoloration and eventual leaf necrosis in affected parts. Crop records indicated growing incidence of this condition with heavy artificial manuring involving lime and/or potash. Magnesium or manganese deficiencies were believed to be a factor.

Wheat

The results of the Canterbury survey of powdery mildew (*Erysiphe graminis*) and of the studies on biological strain specialization of this fungus are to be given in a later report. Of other diseases, *Cercosporella*, eyespot, had been found over a wider area; leaf rust (*Puccinia elymi*) was very severe in parts of North Canterbury, while an infestation of loose smut in a crop of Dreadnought variety was recorded as 14 per cent.

Potato Diseases

A review on potato diseases and their control, based on published research papers covering 1,200 titles, was made by a research student.

Speckled-leaf blotch: Wheat

The fungus *Septoria tritici* was under investigation, and pathogenicity was established by spore suspension inoculations.

Efficiency Standards in Wheat Seed Disinfection

The washing procedure for determining fungicidal dust load on commercial grain samples was tested by the Dominion Laboratory, and indications showed that it was reliable and satisfactory.

Soil Actinomycetes

Morphological descriptions and physiological studies were made on eleven isolates of *Actinomyces*. Antibiotic activity was demonstrated, especially with *Actinomyces dermatonomous* from lumpy wool. Isolates were studied under controlled conditions involving aeration, temperature, and moisture.

Work Completed

The research projects completed were: wheat diseases and insect pests; wheat-seed testing with reference to the disease factor and efficient fungicidal dust coverage; a statistical study of peas emergence trials; studies on a fungus (*Septoria pisi*) causing a foliage disease of peas; and a study on soil actinomycetes.

Bacteriology

The two investigations—pathogenic bacteria in farm milk and lysis of acid-fast bacteria by wax moth hæmolymph fractions—were continued. A machine was constructed to extract hæmolymph from the larvæ by puncturing the heart with a high-speed drill and extracting the hæmolymph with a suction needle. The larvæ survive at least two-weekly bleedings,

WOOL

Progeny testing was continued in a Merino stud with 20 rams under test, and a Romney stud using 8 rams. The wool survey was continued in three properties entailing 4,500 sheep. The Wool Metrology Laboratory made wool surveys on 44 flocks, and work was in progress entering individual ewe data on punch cards for further analysis.

CANTERBURY COLLEGE INDUSTRIAL DEVELOPMENT DEPARTMENT

Director: Mr. T. R. Pollard

During the year, in co-operation with the Canterbury University College and representatives of the Christchurch manufacturers, a new department in the Canterbury College was formed; it is known as the Canterbury College Industrial Development Department, and it services industry and provides workshop facilities for the college. C.C.I.D.D. has functions similar to those of the Auckland Industrial Development Laboratories, but administratively it is part of the Canterbury College, and is financed by a vote from the Department of Scientific and Industrial Research to the college. The Defence Development Section of the Department of Scientific and Industrial Research ceased to exist from 1st October, 1948, and the well-trained staff were absorbed in the new organization.

During the six months of operation the amount of work performed to assist industry in the South Island increased markedly, and at the end of the period there was more work for industry than the existing staff could undertake. In this period, £420 was recovered from industry, £720 from Government Departments, and £3,900 from the University, and financially this can be regarded as satisfactory for the initial six months period.

MASSEY AGRICULTURAL COLLEGE

MANURING TRIALS UNDER ROTATIONAL GRAZING

Mr. A. W. Hudson and Mr. C. V. Fife

The annual applications of lime and fertilizers were made, but lime effects were less obvious than in former years. Fluctuations in seasonal effects is a characteristic of lime. An investigation of the fate of the phosphatic fertilizers applied to the area was continued. This involved a study of the forms of soil phosphorus occurring at successive depths in each treatment area, and for comparative purposes a similar study was made of low-fertility area on the college farm. Besides considerable information on the trends of phosphate fixation in this particular soil type, certain of the findings appeared to have an important bearing on the problem of phosphate fixation in general. The investigations also enabled a critical examination to be made of certain of the methods that had been proposed by overseas workers for fractionation of the soil phosphorus.

SHEEP HUSBANDRY RESEARCH

Mr. E. A. Clarke

The trial of pedigree perennial rye-grass as compared with short-rotation rye-grass was concluded last autumn. The inclusion of short-rotation rye-grass in a seed mixture sown in the autumn gave an appreciable and worth-while increase in carrying-capacity in the following late winter and early spring. Under close grazing with sheep, either under a system of rotational grazing or set stocking, the short-rotation rye-grass failed to persist adequately in the pastures in the following winter and spring, but was replaced by perennial rye-grass. The resultant pastures in terms of carrying-capacity were equal to those originally sown with perennial rye-grass only. As compared with perennial rye-grass pastures, those sown with short-rotation rye-grass in the mixture showed no advantages or disadvantages in so far as thrift and production per sheep was concerned.

ANIMAL NUTRITION PROJECTS

Dr. C. R. Barnicoat

Milk Yield of the Romney Ewe.—The milk yields of over 30 ewes from two groups of animals on the nutrition block were again determined, and the samples analysed. All lambs on the nutrition block are being weighed regularly to obtain information on the effect of twins, season, stage of lambing, &c., on growth rates.

Wear in Sheep's Teeth.—Visits were made to several ewe fairs and farms, and over 500 tagged sheep in the Taihape area (on twelve farms) were mouthed and recorded. Sheep were placed on peaty country (stated to carry soft grass) and on land at the college to obtain further information on the effects of toughness of grasses on wear of teeth. An apparatus was devised for measuring the breaking strain of grasses; different grasses are being compared, and their fibre contents estimated, as a preliminary experiment.

Over 100 tagged two-tooths on the soil erosion experimental area at Te Awa have been mouthed and recorded, and it is hoped that this experiment will show the effect on teeth wear of overstocking sheep on hill country. All sheep on the nutrition block were mouthed and photographed at intervals, and the rate of eruption and wear of teeth in 34 sheep was followed in detail by a new technique.

EXTENSION OF CHEVIOT SHEEP TRIALS

Professor G. S. Peren and Mr. W. R. Hewitt

The Cast-for-age Cheviot Cross Ewe.—The work was continued satisfactorily, and data were collected on weight and quality of fleeces, weight and grades of lambs, and disposal of ewes. Many visits were made to breeders, farmers, and others using Cheviots. Although these visits have not yielded reliable experimental data, much of interest and value has been learnt. Farmer experience with Cheviots in the Taumarunui district is being closely watched since it will yield information on the ability of the Cheviot to thrive in a wet climate.

The Cast-for-age Cheviot Ewe: Comparison with the Romney.—The Cheviot cross experiment to investigate the comparative returns from cast-for-age half-bred Cheviot ewes when run with cast-for-age Romney crossbred ewes, both mated to the Southdown ram, was extended, and the ewes are being run on a nearby typical fat-lamb farm managed entirely by the farmer.

Comparison for several seasons are necessary before positive conclusions can be reached, but the results of the first year's trial may be summarized as follows: death-rates and percentage of dry ewes were similar in each group; lambing of the Cheviots (142 per cent.) was markedly above that for the Romney ewes (107 per cent.); the half-bred Cheviot ewes clipped about 2 lb. less wool; lambs from the half-bred Cheviot ewes were comparable in weight and grading with those from the Romney ewes. The half-bred Cheviot ewes fattened more readily than the Romney ewes in this dry season. It would seem from this season's tests and from past experience that the increased lambing percentage of the half-bred Cheviot is likely to be the most significant factor in determining any difference in total returns per ewe.

FARM DRAINAGE

Mr. A. W. Hudson and Mr. G. Hopewell

Continuous records of outflows were obtained from experiments considered to be of further interest. Five new experiments were instituted, as follows: (1) comparison of the carrying-capacity and thrift of stock between an undrained area and a drained area; (2) comparison of efficiency of 2 in., 3 in., and 4 in. plugs in mole drainage; (3) effect of

thickness of blade in mole drainage; (4) comparison between concrete and baked earthenware tiles for tile drainage; and (5) efficiency of tile drains with tiles spaced in the line and with tiles laid as closely as possible.

PROPAGATION RESEARCH

Dr. J. S. Yeates

Deciduous Azaleas.—The difficulty arising from the failure of rooted cuttings recovering once they have dropped their leaves in the autumn has been encountered. The tip grafting technique has proved very successful, but the idea of cuttings on their own roots is considered to be well worth pursuing.

Tip Grafting Technique.—This outstanding successful method of propagating difficult subjects has been tried under various conditions.

Rhododendron Propagation.—Various devices to enable these plants to be propagated more cheaply were tried.

Fluorescent Lighting.—The underground propagating-chamber was most useful as a guide to the light intensity required for rooting various plants, and work is continuing on these lines.

PARASITES OF SHEEP

Mr. J. H. Tetley

In order to contribute towards a fundamental knowledge on parasitism, and because of the incomplete success of past methods, a new line of study has been adopted that deals largely with the influence of environment on parasites. The object is to study the rhythms in populations of the parasites and gain some idea of the factors that influence them. Hygienic and managemental measures of control, and more efficient application of known drenches, are sought.

SHEEP AND WOOL IMPROVEMENT

Mr. E. A. Clarke

The analysis of data accumulated by the fleece-testing department was continued. A statistical analysis to determine the relative importance of various factors affecting growth of Romney lambs and hoggets is in progress.

The preliminary investigations on the photo-electric wool staple-meter for measuring tippiness of wool staple are nearly completed, and indicate that the instrument has a satisfactory degree of accuracy and speed. The value of the machine in determining the average diameter, break, and tenderness is being investigated, and it is hoped that a rapid technique will be evolved, which would be of great value in studies on the effects of plane of nutrition and other factors affecting wool-production.

PIG RESEARCH

Professor I. L. Campbell

The breeding programme was continued, but in order to reduce the labour and supplementary feed involved in finishing off autumn litters fewer sows were mated to farrow in the summer. All baconers slaughtered are now being evaluated according to the national baconer-judging standards, as well as by the measuring system used in the past, and this will facilitate comparison of carcass quality with stock throughout the country.

THE GENETICS AND GROWTH AND FORM OF THE FLEECE

Dr. F. W. Dry

Studies were continued, and an experiment during the year makes it almost certain that a dominigene causes a single dose of the recessive-N gene, which ordinarily leaves to coat non-N, to come to expression. Anomalous breeding results of long standing thus seem to be explained.

The detailed studies have an even wider purpose in seeking understanding of the forces building the fleece. One aim is to learn how differences in domesticated fleeces are produced, and (from the phenomenon of the pre-natal check) a helpful hint as to how the fleece of the domesticated sheep grows without ceasing has been gained from the hair details of ordinary and N-type lambs, the fleece of the latter being intermediate between those of the former and short-coated wild sheep.

The facts given show that an impressive number of Mendelian phenomena have been found in this large farm mammal. The interactions of the several genetic factors are especially worth study. It is not surprising that these same phenomena and problems have been discovered in laboratory animals, but our knowledge of fibre type detail of a mammalian coat that is most exceptional, in growing indefinitely, makes the sheep unique material for genetical studies.

SEVENTH PACIFIC SCIENTIFIC CONGRESS

After a lapse of years occasioned by the war, the Royal Society of New Zealand, with the assistance of the Government, convened the Seventh Pacific Science Congress, which was held at Auckland and Christchurch in February, 1949.

Officers of the Department served as members of the Main Organizing Committee and of the various divisional committees.

The registrations for the Congress numbered 600; of these, 180 were delegates from overseas representing 17 countries bordering on or having special interests in the Pacific area and its problems. Representatives of UNESCO, FAO, and the South Pacific Commission also attended.

The programme of the Congress was divided into divisions—viz.: Anthropology; Botany; Geology, Volcanology and Geophysics; Meteorology; Oceanography; Public Health and Nutrition; Social Sciences; Soil Resources, Forestry and Agriculture; and Zoology.

The recommendations of the Congress on research proposals and projects were co-ordinated in the final report of a special division on Organization of Research. Although the Congress was concerned with the problems of the Pacific, its recommendations are of interest to the whole world as it is becoming increasingly apparent that the problems of the Pacific are of world-wide significance. The reports and resolutions adopted by the Congress will be forwarded to the Governments and co-operating bodies for their favourable consideration and action where appropriate. Important as these recommendations are, the outstanding value of the Congress to New Zealand was the stimulus given to our young scientists by the opportunity given them of meeting and discussions with scientists who have achieved international fame in their own fields.

SCIENTIFIC LIAISON SERVICE

The policy of strengthening the Department's scientific liaison services, reported last year, has continued, and there is now an establishment adequate to meet present needs.

The overseas liaison officers provide a vital link between research workers and scientific organizations in New Zealand and scientific establishments in other countries. These officers, in addition to other duties, obtain up-to-date technical information on

subjects of special importance, and are able to provide advance information on the more outstanding researches conducted overseas. This information assists the Department in formulating and modifying its own research programmes, and in avoiding unnecessary expenditure, through undue overlapping, on the work undertaken elsewhere. The liaison officers can readily make available to New Zealand workers the results of a vast amount of research, much of which is on a scale quite beyond the normal resources of smaller organizations.

LONDON

The Scientific Liaison Office, London, is established in association with the British Commonwealth of Nations Scientific Offices—an arrangement which secures ready co-operation between the various Dominion and United Kingdom scientific liaison officers and the use of common clerical and other services. Dr. E. Marsden, who is in his second year as our Scientific Adviser, London, has been Chairman of the B.C.S.O. House Committee this year. An Assistant Scientific Liaison Officer was appointed in 1948.

The Office has had a busy year as, apart from the growing number of scientific inquiries and reports handled, arrangements were made for official visitors to and from New Zealand (including the United Kingdom delegation to the Seventh Pacific Science Congress). Dr. Marsden attended several International and Commonwealth Scientific Congresses and two International Standards Congresses. Applications were handled for a large number of professional and technical vacancies in the Department in New Zealand, which were advertised in the British press.

WASHINGTON

The New Zealand Scientific Liaison Office in Washington, D.C., is likewise associated with the B.C.S.O. The Washington establishment will shortly be up to full strength, with two Scientific Liaison Officers: one, the senior, being appointed on a semi-permanent basis for a term of approximately six years initially, and the second officer on a basis of replacement after eighteen months.

MELBOURNE

A senior officer continues to represent the Department as Scientific Liaison Officer, Melbourne. He returned to New Zealand in May, 1948, for a month's renewal of contacts with affairs here.

WELLINGTON

The Scientific Liaison Section at Head Office has been put on a better footing by the appointment of an assistant to the Scientific Liaison Officer, who has other duties in addition to responsibility for the scientific liaison services.

SCIENTIFIC PERSONNEL SECTION

As in the past, considerable difficulty was experienced during the year under review in recruiting scientific officers for the more senior posts, certain of these positions were accordingly advertised in the United Kingdom. Sufficient applicants were, in general, available within New Zealand to fill vacancies for junior graduates and for technical trainees.

A number of bursaries were awarded during the year by the Public Service Commission to enable several of the most promising technical trainees to continue or complete a University degree under more favourable conditions. In addition, a limited number of bursaries were awarded as a method of assisting the Department in recruiting technical trainees with high academic records.

Six post-graduate scholarships were awarded during the year under the terms of the National Research Scholarship Regulations, which are administered in the Department.

The report of the Scientific Man-power Committee, set up in 1947, was published as a parliamentary paper during the year. The recommendations of the Committee are receiving the attention of the authorities concerned.

COMMONWEALTH AGRICULTURAL BUREAUX

The Commonwealth Agricultural Bureaux have again rendered a unique and valuable service to agricultural and forestry research workers in the Dominion, mainly through the abstracting journals and technical communications of the Bureaux.

The organization, which was previously designated "The Imperial Agricultural Bureaux," was established in Great Britain following the Imperial Agricultural Research Conference in London in 1927. It consists principally of two institutes, ten bureaux, and a headquarters. The activities of the Bureaux are controlled by an Executive Council on which the participating Governments are represented, and the funds of the Bureaux are provided by these Governments and from the sale of Bureaux publications. Dr. E. Marsden, Scientific Adviser, London, represents New Zealand on the Executive Council.

The Bureaux activities in New Zealand are co-ordinated through a liaison officer, who is a member of the staff of the Department of Scientific and Industrial Research. In addition, certain specialist scientific officers in this and other Departments and organizations in New Zealand act as official correspondents.

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